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IN COLOUR
BRITAIN'S
TIN MINES

newscientist



A landscape beyond reclamation?



COURVOISIER
'The Cognac of Napoleon'



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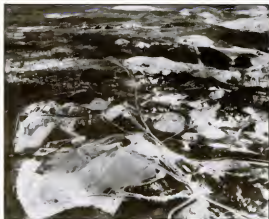
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Cover by: J. Darke/Fotobank International Colour Library

NEXT WEEK

Industrial chemicals
Coal pops the question

Coal tar was the feedstock for all kinds of chemicals until oil replaced it after the last war. Now the wells are running dry, the chemicals industry is once again making eyes at coal

Can we prevent heart disease?

Research for the Third World



Save our wastelands

There have been some spectacular successes in land reclamation (see page 138 of this issue, for example). And in many countries new mining activities have to restore land to its original state when the underground resource is exhausted. But that may not always be the most appropriate response

John Gordon

FOR DECADES, professional and amateur politicians, encouraged by a vociferous band of scientists and engineers, have relentlessly pursued the reclamation of land for which the distant eye sees no use. The approach is as persistent and tenacious as it is conventional and unimaginative. Pits have been filled in and tips levelled to form the ubiquitous British, urban, flat landscape of close-mown turf and lollipop trees. As with many other values, the landscape has been averaged to mediocrity.

In many parts of Britain tips add identity and character to the landscape, isolate and reclines and glistens in the virgin whiteness of the Cornish sunlight, contrasting with the coal-black tips that have heaved into the dull, greyness of Lancashire's sky. Houseman's Shropshire that was once visible from Telford's shopping centre has been very carefully and skilfully gnawed away.

Mineral workings have produced earthworks that are of equal, if not greater, magnificence to Offa's Dyke and the Iron-Age forts. They are important monuments to Britain's pioneering industrial past. Some of the oil-shale bings in the Scottish Lothians have been scheduled as ancient monuments. It is just as desirable to schedule pits, tips and earthworks as it is to schedule buildings and artefacts before uncontrolled enthusiasm hides them from generations.

But no land, nor any building, should be preserved for its own sake and remain unused. Whether owners, councillors, mothers, fathers, grandmothers, grandfathers and teachers have liked it or not, many generations of children have found pleasure and excitement in the hills, hollows, derelict buildings and long-abandoned mines and mineral workings. Derelict land is resilient, robust and interesting, providing private areas that are so necessary to children—land to dirt-track on which cowboys and Indians are for real, and ponds to sail boats that never do.

As children grow up, and the pedal bike becomes the motorbike, they have areas to test their skills, where tumbles cause only a bruise or a tear. But all we are leaving them is the park, the road, the countryside. Why?

These derelict landscapes can take the punishment, they are the places that youth can work off its frustrations without causing too much damage, and where many experience their first taste of love. The Health and Safety at Work Act and the singular dedication of engineers and politicians are denying children the right to grow up as children. The thrills and the

excitement are being taken away, leaving only the bus shelter, the football pitch, the window and the mugger.

Derelict land often forms the only large expanse of land that is not well-manicured and possessed by peak-capped officials. People can take their dogs for walks, train whippets and pigeons free of restrictions. The retired can squat, smoke, reminisce and grow old and die in familiar, comfortable surroundings. Tips are like sea fronts to the old miner.

Disused mineral workings are not just the adventure playground of the young and old but provide many recreational needs. There are no natural lakes in north Buckinghamshire, the sailing, water skiing, windsurfing and angling occur on a variety of man-made lakes mainly formed from the extraction of sand and clay. And whilst derelict land supports the activities of man it provides a home for plants and animals. Mineral workings and industrial processes have created interesting habitats such as inland salt marshes, extensive deposits rich in lime and other substrates that do not occur naturally in a particular region. Cheshire contains extensive inland salt marshes. The lime beds of Lancashire and Cheshire support many otherwise rare or unusual plants, such as marsh orchids and helleborines.

Animals also benefited from these operations: gravel pits have allowed many birds, including the Great Crested Grebe and the Little Ringed Plover, to increase in number or extend their range. Sand pits and flashes (that is, subsidence lagoons) also attract and are casual visitors. Many studies have clearly demonstrated the contribution of industrial processes to the conservation of wildlife in Britain.

The entrenched assumption that all reclamation is desirable must be challenged. It is questionable whether the taxpayer receives value for money from the research and effort that is still uncritically applied to the reclamation of so-called derelict land.

"Derelict" land is a valuable resource that provides opportunities, not constraints. It is the private playground of children, the recreation ground of adults, and home for wildlife. The consequences of levelling it, providing a cover for perennial ryegrass and keeping people off—that is, changing it from land requiring little management to land requiring a great deal—needs to be very carefully assessed. □

John Gordon is a writer, photographer and consultant in environmental education, ecology and the management of natural resources.

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THIS WEEK

Europe may join flights to the planets

THE WORLD'S leading space explorers are looking to Europe for help in probing new corners of the Solar System over the next two decades. A tight budget in Washington and the growing know-how of European space scientists has encouraged advisers to the National Aeronautics and Space Administration (NASA) to recommend new joint space probes.

After two years of study, a blue-ribbon panel of experts this week advised NASA to plan at least four "essential" planetary ventures between now and the year 2000. One of these—a mission to Titan, Saturn's largest moon—is the focus of plans for a joint effort by NASA and the European Space Agency (ESA). An American craft might take with it a probe built by ESA that would enter the moon's atmosphere. Titan is unique in having a thick atmosphere made mostly of nitrogen, with some methane and possibly argon. It is thought to be an atmosphere similar to that on Earth before life began.

Other possible joint missions includes a "Mars aeronomy orbiter" that would investigate the interaction of the planet's upper atmosphere and ionosphere with radiation and particles of the solar wind. The mission is similar to the Kepler project proposed to and apparently shelved by ESA, and is also under discussion in Washington as a joint NASA/ESA venture.

The advisory panel, known as the Solar System Exploration Committee, faced the daunting task of reviving exploration of the Solar System within budgetary limits well below the deep-pocket days of the 1960s and 1970s. While attempting to stay within \$300 million a year, the committee also recommends as essential missions:

- the "Venus radar mapper." This is a scaled-down version of what originally was to be an ambitious orbiting craft that would build up a picture of the planet's surface

Christopher Joyce, Washington D.C.

using radar. The mapper will use components from existing spacecraft to cut costs. It will bring back better information about Venus's geology.

- the "Mars geoscience/climatology orbiter". The orbiter, saving money by using spare parts from Earth-orbiting craft, will circle Mars to determine more about the planet's surface composition and the role of water in the Martian climate.

- the "Comet rendezvous and asteroid flyby". Comet experts in the US are deeply disappointed at missing out on Halley's comet. They will get a new, modular spacecraft called Mariner Mark II that can be adapted to a variety of planetary or other "observer" tasks. For a rendezvous with a comet the craft would carry cameras and

remote-sensing instruments to study and measure the gas and dust boiling off its nucleus. Three likely candidates for study are the comets Encke, Tempel 2 and Honyday-Mrkos-Pajdusakova. All are due to visit the Solar System in the mid-1990s.

Knowing NASA would have little cash to spare, the committee backed off proposals for new landing craft. Meanwhile, NASA has worked hard to restore its trustworthiness with ESA. Two years ago, NASA at the last minute reneged on a joint venture with ESA to send two satellites to the Sun in what was called the International Solar/Polar Mission. Passions have cooled since then, and the committee now recommends that NASA consider building instruments especially for hitchhiking through the galaxy on ESA spacecraft. □

Dealing escalates as Seveso trial opens



Demonstrators playing dead outside Hoffmann's headquarters in Basel last week

THE TRIAL of technicians who let the chemical works at Seveso in northern Italy run out of control seven years ago, scattering 300 grams of dioxin across the district, opened on Monday in Monza, Italy. But the judge ordered a three-week postponement while the plant's owner, the Swiss flavouring and fragrance firm, Givaudan, tries to reach settlement with the 127 representatives of local citizens and organisations who flooded the court asking for compensation.

The civil and criminal actions are inextricably entwined. Three local communities have won settlements from Givaudan and its ultimate owner, the Hoffmann-laRoche combine. Strenuous efforts were made last weekend to settle the outstanding claim of the town of Seveso itself. The company is anxious to make out-of-court civil settlements because it is cheaper. An interim deal with Seveso would also help the company's case for a further postponement of the trial.

As the trial opened, one more case was dropped. The Senno family agreed terms on its dispute over the daughter's year-long bout of the disfiguring skin disease, chloracne. The family accepted £13 600.

The trial itself centres on charges brought

by the regional government against five senior company staff for criminal negligence in the design and operation of the plant. None of the accused appeared in court. They are charged with not installing any equipment to protect the local population from the poisonous vapours which burst out of the plant during the accident.

The plant produced trichlorophenol, an ingredient in the manufacture of the bactericide, hexachlorophene. It overheated when workers left the plant for the weekend without adding water to cool the reaction. One of the accused, Joerg Sambeth, Givaudan's West German technical manager, cannot explain this. The man who could, Paolo Paoletti, the plant manager, was shot dead by terrorists in 1980. Their trial is still under way in Milan.

Other absentees at the trial were local government officials who contravened Italian law by allowing the plant to vent directly to the outside world and others who took 16 days to evacuate Seveso.

Locals are still angry about that delay, but last weekend they were oddly quiet. They are tired of the disruption the affair has brought to their lives and would like to take their money and forget all about criminal charges. □

OBSERVER David Austin

IF YOU HAPPEN TO FIND AN EVIL EMPIRE OF LITTLE RED MEN THE PRESIDENT MIGHT INCREASE OUR SHARE OF THE BUDGET



Setting sail for a deep-sea El Dorado

Ian Anderson, San Francisco

MARINE geologists at the US Geological Survey are fighting to raise money for a year-long scientific cruise that promises to confirm the potential of spectacular oil and mineral deposits stretching from the Arctic to the South Pacific. Their trip, if it goes ahead, could eventually transform the lazy economies of Tonga and the Solomon Islands, threaten the future of the grey whale, and dramatically increase the world's known oil supplies. But the research ship, the S.P. Lee, bristling with equipment for mapping the sea floor, faces a year in dry dock unless \$15 million is raised.

The predicament is a result of last year's reorganisation of the USGS by James Watt, the interior secretary. The funding for the survey's marine programme was slashed from \$24 million to \$13 million a year—money intended for both the Atlantic and the Pacific sections.

So the survey is now selling its research wares to other government agencies and in Washington this month the US Agency for International Development will discuss funding with representatives from Australia and New Zealand. They are reported to be willing to contribute up to \$2 million for the South Pacific leg of the cruise. Industry too is being courted, but time is getting short: sea trials are scheduled for July.

Earlier this month the marine geologists at the survey's western headquarters in Menlo Park, California, revealed what they discovered during a nine-month cruise last year and what they want to re-examine this year. They did not find oil and gas, merely thick sedimentary areas that could indicate their presence. Some of the discoveries were in deep water. It will require improvements in oil-drilling techniques before they can be exploited. Nevertheless, Dr Michel Halbouty, chairman of the Circum-Pacific Council for Energy and Mineral Resources, told the meeting that the findings indicated that as much oil and gas remained to be found in the Pacific as



Charting the Pacific (above) aboard the S.P. Lee



had been discovered so far worldwide. "Any cessation of effort, time or money in the investigation of the Pacific Basin would be disastrous to continued development of this vast, geologically-promising part of the world," he said.

"The area with the greatest potential for immediate returns is the Chukchi Sea, north of the Bering Strait," David Scholl from the USGS told *New Scientist*. Uncommonly warm water in the area will allow the Lee to enter for about 10 days in September—if funds are available.

The Lee has also found promising sedimentary strata in basins near the Aleutian Ridge and Bering Sea. An unusually thick

stratum—13 kilometres in places—was discovered in the Navarin Basin, but the basin straddles a disputed border between the US and the Soviet Union.

In the South Pacific, they found sedimentary deposits ranging from 1 km to 5 km thick near Tonga, the Solomon Islands, and Vanuatu (formerly New Hebrides). This year they hope to take rock samples, along with more sound reflections. "It's pretty obvious that the islands can't live on an economy of copra and fish forever," said David Falvey from the Australian Bureau of Mineral Resources.

Metals are also likely in the area. The geologists believe there are chambers of spreading magma near Tonga and the Solomons. These would lead to deposits of zinc, copper, silver and cadmium. This year they hope to place cameras on the sea floor to search for escaping hot water, which would confirm the existence of the chambers.

Submerged mountains near Hawaii and Western Samoa have also raised interest. The geologists believe these could contain vast quantities of cobalt. "Any given sea mount could have \$1000-2000 million worth of cobalt," said David Howell, the director of the survey's Pacific Marine Geology Branch.

The Antarctic is also on this year's agenda. The S.P. Lee will spend a month on the Ross Sea shelf looking for oil-bearing rocks.

The survey will report on environmental hazards associated with exploration, such as the sea floor and faults. The grey whale uses the Bering Sea and the Arctic Ocean—two prime spots for oil—as its feeding ground, for instance. "We don't advocate. We'll just say what's there," said Howell. □

Gulf oil spill cannot compare with Amoco Cadiz

THE OIL slick that threatens to cause havoc in the Arabian Gulf over the next few weeks comes from a spill less than one-tenth the size of a supertanker's cargo. But the damage it could do is spurring the Gulf states into unprecedented efforts to protect their shallow, near-landlocked waters.

Khalid Fakhro, director of the Marine Emergency Mutual Aid Centre in Bahrain, told *New Scientist* this week that 2000 barrels of oil (half previous estimates) has been flowing from a war-damaged platform in the Iranian Nowruz field every day since the end of January. This is a total of 23 000 tonnes. In 1978 the tanker Amoco Cadiz deposited nearly 223 000 tonnes on the coasts of Brittany.

The Gulf spill first appeared as a slick in a satellite photograph taken at the end of March. Experts estimated that it covered up to 30 000 square kilometres.

The most immediate danger is to the desalination plants that supply nearly all the region's water (there are no permanent rivers in the Arabian peninsula). Kuwait's Ministry of Power and Water last week esti-

mated that water supplies would last for 12 days if the slick reached desalination inlets, or for a month if the population was rationed to 4 litres per person per day. Other Gulf states have fitted booms across the inlets of desalination plants, and suction equipment will clean up slicks.

But precautions are hampered by the fact that no one now knows where the slick is. "We have only observed a few patches this week," Fakhro said, "most of it is still in the war zone". One theory is that the oil has sunk, and is drifting in globules a few metres below the surface of the water.

Although the spill is the largest single oil accident in the Gulf, the waters are no strangers to pollution. According to one report, by the Earthscan organisation, routine ballast-dumping alone accounted for 400 000 tonnes of oil pollution a year by the end of the 1970s. Ironically, the International Convention for the Prevention of Marine Pollution will ban this type of dumping in the Gulf from 2 October. But, as a spokesman for the UN's International Maritime Organisation said, "there's noth-

ing to stop a tanker's skipper dumping oil and blaming it on the war".

Despite the Gulf's long history of oil pollution, little research has been done on the long-term impact on marine life there. One survey, carried out in 1977 by Dr Anthony Nelson-Smith of University College, Swansea, found that oil "... has reached nearly all parts of the coast, sometimes in considerable quantities. This has undoubtedly caused temporary local damage and may well have contributed to the general decline of the shrimp fishery."

Two British experts on oil pollution travelled to Bahrain this week to see how marine life is coping. One of them, Dr Andrew Price of York University, said he would be looking at the impact of the spill on turtles, shrimps and dolphins. The spill has seen nothing on this scale before.

But worse disasters could come. The Iraqi air force last week announced it would attack with Exocet missiles any ship taking on Iranian crude oil. The sinking of a laden supertanker would make the present slick look small indeed. □

Accelerator was an expensive failure

ONE OF the centrepieces of Britain's post-war high-energy physics programme—the electron accelerator at Daresbury in Cheshire—is this week labelled an expensive failure by a research team. Ironically Sir Alec Merrison, the laboratory's director when the project was approved in 1962, warned then, in an article in *New Scientist*, of the dangers of the multi-million pound accelerator becoming a white elephant.

In its critique of the project, known as Nina, the Science Policy Research Unit (SPRU) of the University of Sussex, says:

- Only six papers a year were produced from research using the machine, whereas similar devices abroad were producing up to twice as many
- The scientific impact of the work was minimal. Research papers from Daresbury have not been quoted by other physicists as important reference material. Other accelerators had far more citations

- Physicists in America and Europe had a low opinion of Nina and Daresbury's physicists themselves thought it was mediocre

John Irvine, who wrote the SPRU report with Ben Martin, told *New Scientist* that the results raise questions about British policy towards high-energy physics in the past 20 years. "They show that a major capital investment, amounting to £160 million in current prices, did not produce much physics and should have been closed long before it was in 1977."

He argues that Britain was wrong to spend so much on accelerators. As well as Nina, there was the proton accelerator at the Rutherford Laboratories, and Britain

contributed to similar accelerators at CERN in Geneva. Nina was built too late to compete with other accelerators that do done most of the early work, leaving Daresbury with little else to follow up, says Irvine. "It was a classic case of too little, too late." However, Professor John Gunn, who chaired the working party which recommended the construction of Nina in 1960, said that the delay was inevitable because of the financial constraints at the time.

Nina was finished in 1966, four years after the Cambridge accelerator in America, and two years after the German equivalent. It was less powerful than both of these. Gunn argues that Nina should have gone through a second, refurbishing phase, to bring it in line with the German accelerator, Desy.

Nina was used mainly by the northern universities such as Gunn's at Glasgow. The southern universities had the proton accelerator, at the Rutherford Laboratory.

"At the time this decision was made high energy physics took a major slice of government research budgets. Part of the problem must have been competition between northern and southern universities," says Irvine.

In his 1962 article in *New Scientist*, Merrison noted that Gunn's original report backing the accelerator had warned that "the competition in this field was already very keen and [he] pointed out that if full value was to be secured from the project it should be started immediately". In fact two years elapsed before the then minister for science, Lord Hailsham, gave the go ahead.



Slow-coach accelerator

Vancouver doctors query mass-murder verdict

A STUDY by doctors in Vancouver has raised questions about the accuracy of tests used to show that infants were murdered with drug overdoses at Toronto's Hospital for Sick Children. (*New Scientist*, 10 March, p. 636).

A police investigation, supported by medical studies from the Centers for Disease Control (CDC) in Atlanta, showed that at least seven and possibly more than 20 young patients at the hospital's cardiac ward had been killed by deliberate overdose of the potent heart drug, Digoxin.

The Vancouver group discovered that a mysterious substance, dubbed "X", is found in the blood of newborn babies and affects an antibody test used in detecting Digoxin. They say that could mean that tests would show the presence of Digoxin where none was administered.

Their findings are published, as a letter, in last week's edition of the *New England Journal of Medicine*. The four doctors say they sent their findings to an Ontario government inquiry into the hospital deaths. But the information was not passed on to either the hospital or the police.

Ontario's Attorney-General, Roy McMurtry, says he stands by the CDC report and Digoxin expert, Alois Hastreiter of the University of Illinois, says post-mortem lesions found in some of the patients were "far too high to be explained by any naturally occurring substance".

The Hospital for Sick Children says the Vancouver study could support its original reports on the deaths—that they were not due to foul-play.

Council called to account

NEXT Monday ministers will spend the day with leaders of Britain's new Engineering Council, asking what progress has been made in the reorganisation of Britain's engineering profession. Since it first met 15 months ago, the council has spent £732 000 setting itself up but seems no nearer completing its task of replacing the ineffectual Council of Engineering Institutions in such areas as improving engineering education, taking over registration of engineers and improving the status of the profession.

Nuclear dump proposed

NIREX, the UK's new radioactive waste management organisation, has confirmed that a former anhydrite mine in Cleveland is a candidate for an underground repository for intermediate-level radioactive waste.

The mine, whose workings extend beneath Billingham, is owned by ICI. Anhydrite was used in the production of ammonium sulphate and cement. After the mine was closed in the early 1970s, ICI obtained permission to use the mine to store up to 9 million tonnes of crude oil, but the consent was never implemented. Peter Curd, a spokesman for NIREX said this week that "preliminary approaches" had been made to ICI about the mine, which is some 300 m deep.

But he stressed that the promised shortfall of possible sites—for trench burial and underground disposal—would not be announced until later this year—probably in the autumn.

Milk code is sop

THE INSTITUTIONS of the European Community are in angry disarray over the drafting of a code to govern the sale of infant formula—the substitute for breast milk. Last week, in a stormy session, the European Parliament threw out a voluntary code, proposed by officials at the European Commission, which had been drawn up by the baby-food companies themselves. Instead the MEPs renewed their demand for a directive, based on the World Health Organisation's code, that would be binding on the industry.

They say that the voluntary code will allow the firms to continue their aggressive marketing of the infant-formula—including using health workers to promote it. A similar voluntary code, formed by British firms has been proposed by the Department of Health (*New Scientist*, 20 January, p. 143).

Cyclosporin-A is licensed

CYCLOSPORIN-A, a drug that can prevent the body rejecting bone-marrow transplants, has been given a licence for general use in Britain. Now its manufacturer, the Swiss firm Sandoz, is filing details of clinical trials to show that it is safe for use when organs, such as kidneys and hearts, are transplanted. And Britain joins Switzerland as the only country that has approved the drug, usually known as Cy-A, for use outside clinical trials.

Cy-A is credited with having doubled the survival rate of leukaemia patients who have been given new bone marrow at the Westminster Hospital, London. Its great advantage over other immunosuppressants is that its blocking effects on the body's immune system is selective.

Locust plagues ended

THE WORLD may have seen the last of the ancient scourge of the locust. This claim is being made by experts at the United Nations Food and Agriculture Organisation in Rome. They believe that international satellites that photograph the surface of the Earth mean that any sudden infestation of locusts can be nipped in the bud using modern pesticides.

Landsat and Meteosat satellites regularly relay aerial pictures of locust-infested desert areas. They can spot conditions where the desert locusts are likely to breed rapidly and move into crop-growing areas, where a single swarm can consume 80 000 tonnes of corn a day—enough to feed 400 000 people for a whole year.

Breeding locusts



Students' pockets bulge with silicon profits

ENTERPRISING students at California's Stanford University are making a mint from high technology by designing and marketing computer hardware and software. With Silicon Valley on their doorstep, the students are running small but growing computer companies from their dormitories and houses.

One student employs 25 others to make software. His business, born last June with \$75 000 from a venture capitalist, has been valued at \$1 million and is about to market a three-dimensional video golf game which simulates a championship course in California.

A graduate student in mechanical engineering is president of a company which last year made \$1 million by manufacturing a machine that cleans and decontaminates microprocessor chips for Silicon Valley's semiconductor firms. He claims that there is no competition and predicts \$3 million in revenue this year.

Another student, working from a basement, grossed \$100 000 last year by writing software and doing computer programming for 20 customers, including the physicist, Edward Teller, and economists, Milton Friedman and Arthur Laffer.

There are so many students involved that a Center for Entrepreneurship has been formed to offer advice and put them in contact with venture capitalists.

University officials say the phenomenon is part of a national trend—Dartmouth, Harvard and Carnegie-Mellon Universities also have student entrepreneurial centres.

The reasons for Stanford's success are not hard to find. Necessity is one. Stanford tuition fees have now reached \$9000 a year and some students are paying their way through college. Finding a niche is also important as many of the big electronics companies have frozen recruitment while they weather the recession. Atari recently sent a shiver through the industry when it laid off 1700 employees.

Opportunity is another reason for the entrepreneurial boom. "It's expected that you will get your hands dirty with ideas," said a university spokesman. The area has encouraged entrepreneurs and investors

Ian Anderson, San Francisco



The world at their feet

since the late 1930s when engineering professor, Frederick Terman, the acknowledged "father of Silicon Valley", attracted engineers and scientists from the east and helped them find money for their work.

There, is in addition, the lure of success. A former electrical engineering student is now in charge of a microcomputer company which generated \$50 million in revenues in 1981 and has an annual growth

rate of 200 per cent. The company is called Cromemco, after the dormitory, Crothers Memorial, where it all started six years ago.

The university actively encourages the entrepreneurs. The university's patenting and licensing experts give advice and students are allowed to drop out of courses while they pursue their business interest before returning to school. This liberal attitude has its benefits for the university. Some ex-students have given shares in their company in return for the use of university facilities.

The entrepreneurial bug is by no means confined to computers. An economics graduate and a masters student in electrical engineering recently founded a fibre optics company that has a \$2 million contract with Walt Disney Studios and 1982 revenues of \$1 million.

Perhaps the most bizarre example involves Bill Hoskins, a masters student in exploratory physics. By the end of each summer Hoskins has his family freezer filled with about 12 000 individually-wrapped yellow jacket wasps. The wasps are worth about \$7000. Hoskins sends them to a laboratory on the east coast where their venom is extracted, processed and injected into patients who are severely allergic to yellow-jacket stings. Gradually they are building up a resistance to a sting that could otherwise kill them. □

Ban on lead in petrol—but lead pipes remain

THE British government's move to ban lead from petrol, announced on Monday, masks its continued inaction on possibly the most widespread source of lead pollution. Some 45 per cent of British households drink water that has passed at some stage through lead pipes. Yet it is still not certain exactly how much lead may be taken in from this source.

The Royal Commission on Environmental Pollution, whose report finally prompted the government to make its decision, estimates that some people are taking about 300 micrograms of lead a day from their drinking water. The EEC recommends that tap water should not contain more than 50 micrograms per litre.

The Royal Commission expresses its surprise at the ignorance of water authorities, which still do not know the scale of the problem. It recommends that the government should set a firm date for these authorities to complete surveys of their water supplies.

The report pinpoints areas with very soft acid-water as presenting special problems. Lead is often much more soluble in this type of water, although even alkaline water can dissolve the metal.

The Royal Commission wants more grants for home owners to remove lead pipes. But the environment minister, Tom King, could not give any firm commitment to further government funds. □

Defence electronics for the doves give peace a chance

ADVANCES in micro-electronics are making it possible for countries to switch to a military strategy that is purely for defence and has no offensive capability—if they want to. This is the thinking behind a new organisation called Just Defence that was launched in London this week.

Professor Frank Barnaby, a former director of the Stockholm International Peace Research Institute and co-founder of Just Defence, said that "staggering advances" in microelectronics and communications systems mean that the technology for stopping tanks, aircraft and ships is already available and suitable for the battlefield.



Barnaby believes that, using sophisticated technology, it would be possible for countries to establish an electronic Maginot line using sensors and remotely-piloted vehicles, which could identify attacking forces. Enemy tanks could be illuminated with laser beams and destroyed by missiles homing in on the laser frequency.

Stan Windass, another founder, said it was now possible to "create a new language of defence". The new organisation plans to carry out lobbying, education and further research into non-provocative defence methods.

Barnaby doubts whether the United States and the Soviet Union would be interested in equipping themselves just for

defence at present. But he feels that West European countries "are not being sensible" if they reject non-provocative defence. Sweden, he said, is already moving towards such a posture. No matter what the super-powers plan, Europe can now consider becoming nuclear-free.

"From an economic point of view," Barnaby believes, "countries will have to start this soon. Offensive weapons are becoming too expensive for smaller countries to afford". A non-provocative, and hence non-nuclear, defence would remove a key factor driving the arms race, he says. "If a military posture is demonstrably defensive the hawks in the neighbouring system will find it harder to convince their own establishment that they need new weapons for self protection". □

Animal groups press for pain clause

PROPOSALS for new legislation on animal experiments were submitted to the Home Secretary this week jointly by the British Veterinary Association, the Fund for Replacement of Animals in Medical Experiments (FRAME) and the Committee for Reform of Animal Experimentation. For some time the three bodies have been working to reach agreement on practical reforms which they now want the government to include in its forthcoming White Paper on animal experiments.

Central to the proposals is a statutory "pain clause". This would require prior authorisation from the Home Secretary for any procedure "likely to cause pain, suffering or distress of more than momentary duration or trivial intensity, which cannot be alleviated". Permission would be given only where the procedure was "judged to be of exceptional importance in meeting the essential needs of man or animals". In making such judgments, the Home Secretary would call on expert advice from licence sponsors and referees, the Home Office Inspectorate and a properly-balanced advisory



Putting pain to paper

committee that would oversee the code.

He would make an annual report to parliament giving the number of exemptions to the basic "pain condition" which he had allowed in the year.

Clive Hollands, secretary of the committee for Reform of Animal Experimentation, said that these safeguards represented the minimum of measures which would be acceptable to public opinion. They were workable and reasonable and should be difficult for the government to turn down.

Dr Michael Balls, chairman of FRAME, believed that "the long term prospect of eliminating the need for live animal experiments altogether must rely on the development, validation, acceptance and adoption of alternative methods".

Speaking for the British Veterinary Association, Neil King, its president, felt that the joint proposals represented a sensible middle ground. He added that "this significant meeting of minds between responsible welfare organisations concerned for experimental animals and my profession, deeply involved as it is in the protection of all animals used by society, is a major advance in establishing a cornerstone for legislation in this field".

America prepares for battle over TV satellites

THE US is preparing for a showdown with other North and South American countries over plans to launch satellites for beaming TV to roof-top aerials. No fewer than 12 companies in the US say they want to put craft into space for this purpose. The other nations fear that the American vehicles will hog the available space in the geostationary orbit 36 000 km above the Equator, leaving no room for their own satellites.

The US will face the complaints of its neighbours at a meeting next week in Lima, Peru. Representatives of the telecommunications administrations of countries in the Organisation of American States will take part in the discussions.

But the real decisions will come in June, at one of a series of meetings held under the auspices of the World Administrative Radio Conference. The five-week gathering in Geneva will thrash out orbital positions for all the TV broadcasting craft that the American countries plan. The positions for similar craft that will serve Europe, Africa and Asia were agreed in 1977.

Washburn Abbott, who will lead the US's delegation to the Geneva conference, told *New Scientist*: "I hope we can settle this issue amicably without too many political problems."

Satellites for broadcasting TV will enter an orbit already crowded with about 150 communications vehicles, mainly for carrying telephone calls and streams of data. The existing craft mainly receive and transmit in the 6-4 gigahertz band. They have to be separated, normally by 4° (some 3000 kilometres), to avoid radio interference.

The new broadcasting craft will use a higher frequency, at around 12 GHz, and so will not interfere with the communications satellites. But because the new craft will broadcast at a high power, they will have to be spaced a long way apart so that TV sets in, say, Canada do not receive signals meant for the US.

This issue will be at the crux of the negotiations in Geneva. Depending on technical arguments, the conference will decide on a spacing for satellites using the same frequency that could be anywhere between 4° and 10°. On this will depend the number of craft that can be squeezed into position.

The US's Federal Communications Commission will argue for a total of eight orbital slots for American companies. The slots would be placed in four "service areas" at longitudes between 99° and 170° West. Into these can be allocated enough satellites to transmit the 70 channels of TV that American firms say they want to broadcast. One "slot" can be home to as many as five satellites as long as they do not use exactly the same frequency. Each firm with a broadcasting service may need four

satellites to reach all the US's time zones.

To add to the American demands, Canada has applied for slots will actually launch satellites. Only Satellite Television, a subsidiary of Comsat, has announced it will build a craft—for a service in 1986. RCA typifies the position of the others. A spokesman said last week his company "is still analysing the market".

To complicate the issue, observers predict that not all the American companies that have applied for slots will actually launch satellites. Only Satellite Television, a subsidiary of Comsat, has announced it will build a craft—for a service in 1986. RCA typifies the position of the others. A spokesman said last week his company "is still analysing the market".

New deal for cyclists

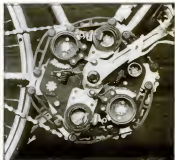
A NEW British company has been set up to exploit an automatic bicycle transmission system, which is claimed to be the biggest breakthrough in bicycle gears since Deraillleur invented his system in the 1920s (*New Scientist*, 6 January, p 23).

The formation of the new company, Deal Drive International, follows a row between the inventor, Michel Deal, and his former collaborator, Dykings Industries. The rift arose because Dykings wanted to make complete bicycles, while Deal wanted to stick to manufacturing the drive mechanism. The new £400 000 company has bought the world rights to the system from Dykings.

The new company will market the transmissions but will subcontract the manufacture of the automatic transmission. The transmission has 16 gears and the gear change is effected simply through pressure on the pedals.

David Nicholas, Deal's marketing director, says the company will be producing gears by the end of the year and

plans to build up production to 1 million units a year within two years. The company will also be marketing a "limited edition" of 2000 bicycles with the transmission this spring.



New firm gears up

Britain bites the bullet over Depo-Provera

THE ATTENTION of the world's drug companies will next week be focused on a conference room overlooking the River Thames in London. It is the venue for a public inquiry to decide whether the controversial injectable contraceptive, Depo-Provera, should be licensed for long-term use. If the licence is granted, it will be an important step towards international acceptance of the drug.

Depo-Provera has been available for short-term use in Britain since 1978. But fears that it would be given to poorly-educated women or ethnic minorities, without their informed consent, led the Health Minister, Kenneth Clarke, to refuse the drug a full licence last year. In addition, the drug's critics are worried about the long-term effects of Depo-Provera—particularly its potential for causing cancer.

One of the hearing's key witnesses, Dame Josephine Barnes, has estimated that "several thousand" British women could benefit from a favourable decision for Depo-Provera. This would bring the American manufacturers, Upjohn, up to £30-£40,000 per year. Much more important would be the effect of the panel's decision on the drug's use in developing countries and on licensing decisions still pending in both America and Canada.

In January this year a public inquiry was held in America, at Upjohn's request, after the Food and Drug Administration (FDA) had again turned down the company's licence application. A panel of medical and scientific experts heard Upjohn's case in much the same way as the British panel will hear evidence next week.

The American panel has now adjourned to decide what recommendations to make to the FDA. But its members are thought to be waiting to see what its British equivalent comes up with.

The Canadian health authorities in turn

The diabetic who wasn't

THE CASE of the diabetic who took insulin for 52 years, only to turn out not to need it at all, is bemusing doctors. For most of his life, doctors had assumed that the man was incapable of making his own insulin in the cells of his pancreas. In fact he had been churning them out all along. To compensate for the huge doses injected into his body every day, his immune system had evolved to recognise the alien insulin and to deactivate it.

Tests revealed that the man—who is known only as "John Smith"—could survive without injections of insulin. His very mild diabetes could be easily controlled by restricting his diet.

The 69-year-old man had won the Joslin medal for successfully taking insulin for 50 years. The medal is named after the late Dr Eliot P. Joslin, who wrote the standard textbook on the treatment of diabetes. There are only 650 medalists worldwide, and 150 in Britain. "We have not dared to ask whether our patient should return his Joslin medal," says Dr Mary Armitage of the Edinburgh Royal Infirmary, in her report in the *British Medical Journal* on her unusual patient. □



Third World contraception: the big market

will be watching both their American and British counterparts. Upjohn submitted a licence application for Depo-Provera in Canada earlier this year. Last November the Canadian Advisory Committee on Reproductive Physiology—similar to one of the sub-committees of Britain's Committee on Safety of Medicines—

declared that Depo-Provera was safe. This must put the Canadian health minister in a similar position to Britain's Kenneth Clarke, when his advisory committee recommended that last year Depo-Provera should get a licence.

Clarke ignored his experts advice, so his Canadian opposite number may do the same. But, having seen Upjohn dig in its heels in Britain and America, the Canadians may be less keen to begin a long battle over the drug. Even when the Canadians, British and Americans have reached a decision, Upjohn's lawyers won't find themselves out of a job. Next on the agenda will come Australia, Italy, Spain, Eire, Taiwan, Yemen and Chile, to name but a few.

The West German drug company, Schering, will also be watching events. Its own shorter-acting injectable contraceptive, Noristera, is now marketed in 31 countries, compared with Depo-Provera's 80, and is used widely in the World Health Organisation's family-planning programmes. □

Curry-eating teenage smokers cough on

SMOKING among 16-19 year olds in Britain has dropped by some 15 per cent over the past decade, according to a new survey of the habits of young people carried out by the Cancer Research Campaign. But there is bad news as well.

The results, based on replies from nearly 16,000 school-children, aged 8 to 20, in the counties of Cumbria and Tyne and Wear, show that 17 per cent of the children smoke one cigarette or more per week.

Regular smoking ranged from 1 per cent of 10 year olds to 30 per cent of 15 year olds. By 19 years old the children smoked as much as their parents—28 per cent of boys indulged compared with 36 per cent of girls.

Smoking shows its health effects early on, the researchers discovered. Thirty-two per cent of regular smokers reported frequent coughs compared with 22 per cent of non-smokers. One per cent of the sample had puffed their first fag by the age of four, but the bulk of experimentation is carried out by 9-12 year olds. The CRC sees this group as a prime target for an anti-smoking campaign.

Smoking habits of boys and girls are roughly the same up to the age of 12, but as adolescence approaches, more girls than boys smoke regularly. Some 23 per cent believe that smoking keeps down weight. This may be another target for a campaign.

Another finding that may prove useful in keeping children away from the wicked weed is that they are much influenced by

parents, teachers and peers. Of regular smokers, 41 per cent thought their dads would not disapprove of smoking, compared with 8 per cent of regular smokers who thought he would disapprove. Simi-



Spring-time light-up

larly 26 per cent of regular smokers thought their best friends would not mind them smoking, compared with 2 per cent of those who thought their best friends would mind.

The survey is the largest ever carried out in Britain. Questions about smoking were cunningly mixed among questions about social life and musical tastes. These brought some surprise findings. For example:

- The favourite food of regular smokers is curry compared to apples for non-smokers.
- Regular smokers drink more alcohol and go to more discos and music "gigs" than non-smokers.
- Regular smokers like rock and reggae music, whereas non-smokers liked classical music and pop. □

India takes a hard line on computer software

INDIA could be exporting 10 per cent of the world's computer software, worth \$1000 million each year, by 1986. The plan is to exploit the shortage of skilled programmers in the West. It aims at increasing the number of trained programmers from the present 500 a year, to more than 22 000.

The scheme is the brainchild of the Computer Society of India. Its training programme is boosted by a software export policy introduced by the government last year. Under the policy, companies that want to import computers to India have to show that they also have export orders for software. These must equal 20 per cent of the computer's value.

But there are formidable problems facing this ambitious plan and India's infant software industry. At present there are just 1000 software specialists in the country. Of 500 new specialists trained each year, some 200 leave India for the US. At one college 20 computer students graduated last year. But 18 subsequently left for scholarships in America.

Professor P. V. S. Rao of the Indian Institute of Technology (IIT) is well aware of the problem. "It is quite clear that there is a major shortage of trained manpower in computer science in the US, which is threatening the technological progress of that country and the brain drain from India is helping to mitigate this problem."

American organisations find that Indian programmers are cheap to train. It costs between \$30 000 and \$50 000 to produce a B.Tech in India, compared with



Old IBMs baulk the new software revolution

\$300 000 to \$400 000 to train a student in the US.

India has very few fourth generation mainframe computers which have been available in the West for a number of years. Many companies run IBM 1401 computers, which were superseded by the IBM 360 in the early 1970s. Programmers who want to use the latest technology find this frustrating. Even those firms who have modern machines, tend to run them with software designed for earlier models.

Much of the \$50 million of software exports in 1980 consisted of what is called conversion work: the recoding of programs so that they can be transferred from one computer to another. Indian software companies are sending programmers to the US to undertake this type of work. Tata Burroughs, for instance, sends most graduates it recruits to the US after an initial training period of three months.

Multinationals have in the past been checked by laws which require Indians to take majority shareholdings in foreign

companies operating in India. These regulations have, for instance, forced IBM out of India altogether.

But the latest scheme to boost exports and control imports does not please India's software industry. Executives claim that the government is fouling up development by preventing the influx of badly needed computers. The regulations are also open to abuse: one company was found to be importing old computers and exporting blank computer tape masquerading as software.

Britain at present makes little use of Indian software expertise. A delegation of Indian software producers who came to Britain last year received only three responses from 190 British computer firms they visited. Julian Bogod of the UK Council for Computing Development said that the plan to sell \$1000 million of software was "over ambitious to say the least".

Roy Green, software field operations manager for the British firm, Systime, believes that India's best bet for expansion is to go for what is called systems software: programs that run the computers themselves. "They would do best to concentrate on technical software, rather than applications where you have to be in close touch with your customers," he said. □

No more fame for defamers

THE BRITISH parliament, the fount of Western democracies, may soon adopt the technology of the radio station phone-in to prevent its members being sued for making defamatory remarks during debates that are broadcast to the nation.

Words spoken in parliament and reported in Hansard, the official record, are privileged—that is they are immune from legal action. But, when parliament woke up to the electronic age and first allowed its proceedings to be broadcast in 1978, nobody was sure whether those broadcasts were also privileged. One MP was sued for alleged libel in June 1978 over a jibe in the House about IRA supporters. But the case never came to court.

Now a select committee has ruled that broadcasts are not privileged. So it has come up with the idea of a tape "loop" to delay the broadcast of "live" debates for long enough for an engineer to hit a panic button until the offending words have passed. The technique was developed to keep rude words off radio phone-ins.

But the select committee seems to be technically ill-informed. Its report refers to the "few minutes" in which broadcasters can consider whether what has been said is on the wrong side of the law. In fact phone-in loops delay things by just seven seconds. So, short of sending the recording tape on a long detour through the corridors of the Palace of Westminster before it goes on the air, the parliamentary censors will have to work faster than they think. □

Old university pecking order draws new blood

IF YOU want to know the pecking order of the various departments in Britain's universities, try looking at the shareout of the 312 new academic posts announced by the Department of Education and Science last week. The jobs are an attempt to inject "new blood" into university departments where the turnover of staff has fallen to a trickle and to give new emphasis to information technology. The theme that emerges, however, is: "To those that hath, shall be given." Cambridge University has the largest total—24 new posts, six for information technology, five in engineering and technology, and four each in medicine and physical sciences. Oxford has 21, including four for information technology, six in medicine and four in physical sciences.

Those more modern universities that were worst hit in the 1981 university cuts have done badly again in the new handout of jobs. Salford has two new posts, Bradford three, and Keele one.

The selection seems to have taken into account the moves within London University to amalgamate some colleges and form five science centres. Chelsea College, which is under strong pressure to merge with one of the larger colleges, does not

appear in the list, even though it has a strong electronics department.

The biggest set of posts is the 70 awarded in information technology to "boost the training of qualified manpower and expand research". In the separate "new blood" scheme, physical sciences has done best, with 66 new posts. Engineering has 48, medicine 43, and biological sciences 25, with 20 for maths, 17 for social studies, 15 for arts, and 8 for agriculture and veterinary studies.

In the scramble for posts, universities put in 2250 applications. According to the government the main criteria for the new blood posts were "the age structure and recruiting prospects in the departments concerned" and "the likely contribution of the posts to research and scholarship". The University Grants Committee and the research councils worked together on the selection job.

Meanwhile, the Royal Society has received more than 500 applications from scientists for its own 30 "elite" new blood fellowships. Committees for four subject groups will sift the applications and suggest short lists to the Royal Society's Council, which should make the final decisions in May or June. □

The greening of the Cornish Alps

White plains, white hills and dazzling blue lakes formed the landscape that followed clay mining. English China Clays has been so successful at reclaiming the land visitors notice only the unreclaimed sites

Michael Allaby

MINING is a traditional Cornish industry. Centuries before the first holidaymakers stepped on to the county's beaches, men were hewing hard rock, deep underground, to extract the ores that brought wealth, and from time to time even political influence, to their remote, windswept peninsula. They cared little for the landscape in which they worked. Scenery filled no bellies. Smoke billowed forth on those days when the air was still, and spoil tips grew unchecked. Eventually the scars healed, more or less, and today many apparently natural heaths are no more than those ancient tips, covered in vegetation that colonised them at its own slow rate.

The biggest extractive industry in Cornwall today is the mining of china clay. It differs from its predecessors. It is an open-pit operation, and therefore its impact on the environment is considerable because it works, as it were, in full public view. Its waste production probably is no greater than that of other extractive industries, but as its production has increased so has the amount of waste. This would be serious enough, but because of the nature of the material with which the industry works, the pits and the spoil heaps are very conspicuous. They are almost pure white.

The clay is separated from the matrix in which it occurs by washing it out, using high pressure "monitors", much like water cannons, then employing settling and flotation techniques. This uses large quantities of water that is stored in old pits, where it forms bright blue lakes. The waste consists of rock and earth overburden and sand, which must be tipped, and micaceous residue (sludge) made of coarse particle clay, mica, quartz and tourmaline. This is pumped into settling areas behind dams, where it dries slowly into pure white plains. The landscape, then, is one of white plains, white hills and dazzling blue lakes. It resembles no other landscape: SF films are shot in it.

Today that landscape is changing, as attitudes have changed. Mineral extraction is an activity as "natural" in Cornwall as is coal mining in South Wales, and it provides much local employment, but its despoliation of the landscape is no longer acceptable. English China Clays, a company formed at the end of the First World War, inherited the wastelands of more than a century of china clay workings, and then increased their extent. Some years ago it decided the damage must be repaired, and Derek Owen, a landscape surveyor with the company, who retired recently, was put in charge of that repair.

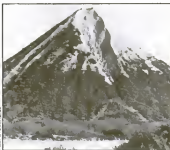
Owen urged that restoration should not be merely cosmetic. Reclaimed wasteland should blend into the landscape and should be capable of supporting the uses to which land is put in the surrounding area. When John Elkington described the reclamation plans in 1978 (*New Scientist*, vol 77, p 13), work was in a fairly early stage. Now, 10 years

into the programme, it has advanced much further and many of the problems that Elkington mentioned have been solved. The result is possibly the most ambitious programme of industrial wasteland reclamation in Britain, with lessons that can be applied widely in other reclamation programmes, and it is highly successful. The "White Alps" are disappearing.

The Cornish china clay (or kaolin) occurs in primary deposits. In the United States, Australia and other parts of the world, deposits are secondary and are mined with much less disturbance by digging them from the sites to which natural processes have moved them. Such landscapes can be restored more easily than those in Cornwall. Ball clay, which English China Clays mines in several parts of Britain, is also extracted from secondary deposits.

The granite outcrops that produce a succession of high moors along the spine of Devon and Cornwall are late Carboniferous (about 300 million years old), and probably are linked some distance below the surface to form a single, large batholith. The composition of the rock varies, but around St Austell there is lithionite granite, which contains pale or white lithium mica and kaolin.

In some places, the kaolinised rock is overlain by apparently unaltered rock.



The mining of china clay (right and far right) leaves a conspicuous mark on the landscape. Vegetation very slowly establishes itself on the old spoil heaps (above), but these conical tips never sit naturally on the Cornish moors

Cambridge University/English China Clays



This suggests that kaolinisation is a hydrothermal process in which acid solutions move upward, changing the hard rock into kaolinite while leaving mica and quartz unaltered. The kaolin, then, lies in a matrix of mica and quartz and occurs in a series of funnel- or trough-shaped deposits.

It is mined by removing the soil and rock overburden and digging a pit. As pits become deeper they must also become wider in order to prevent the sides from becoming so steep they are unstable. In time a limit may be reached, not because of the depth of the pit but because it becomes too wide and approaches land that must not be disturbed. Pits dug near the edge of a deposit may be worked out, but those over the centre of a "funnel" are not. Borings made at the deepest of the present pits have failed to find any bottom to the deposit. What is more, the deeper the pit, the higher is the quality of the clay it produces. But as the depth increases so does the cost of removing materials. Traditionally the practice has been to abandon old pits when it became uneconomic to go deeper, but to return to them when the price for clay improved or when a technical innovation made extraction cheaper. It is unwise, therefore, to back-fill pits using their own waste. At the same time, waste tips must be placed on land that does not conceal deposits that might be worked in future. Thus the pit and tip area has increased and

continues to increase. By 1984, English China Clays estimates it will occupy almost 3000 hectares.

There is a great deal of waste. For every tonne of kaolin there are 6 tonnes of sand, 1 tonne of secondary mica and 1 tonne of overburden. At present the company produces, and must tip, about 20 million tonnes of waste each year.

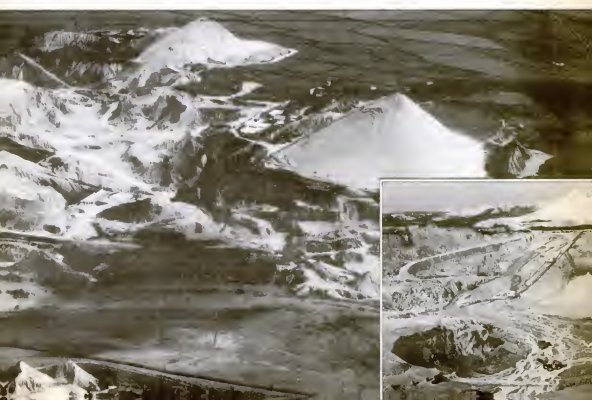
The old tips were formed by dumping material at the top and allowing it to fall into its natural angle of repose. Such tips were conical in shape, their height determined by the ease with which material could be moved to the top. Those tips contained overburden, sand and mica, all mixed, and once work on them finished, very slowly they were colonised by vegetation. After about 30 years they would support ling and heather, then gorse would become established. Some 60 years after work on it ended a

tip would be covered with shrubs, usually dominated by rhododendron and willow. After more than a century it might support oak and birch.

Modern tips are built differently, and their composition is different. Since the Aberfan disaster in 1966, the law requires that overburden be separated from other waste, and the dumping technique produces a new shape. Sand, with no earth in it, is tipped in long "fingers" that eventually join to make a flat-topped hill, more than 20 m high, with steep sides. This forms a stable platform, and further tipping can



There are plants that will grow on the sterile mica plains





take place until the tip rises to 100 m or more and is shaped rather like a stepped pyramid.

The sand is very porous. Water drains from it rapidly, carrying away any soluble plant nutrient that may have been added. There is little nutrient present naturally, because chemically the sand is unable to retain it, and there are no soil micro-organisms or fauna. It is acid. A few centimetres below the surface the pH typically is 4.5 to 4.0, but a pH of 3.5 to 3.0 is quite common. The only point in its favour is that it contains nothing that is toxic.

The first step in reclaiming these spoil heaps was to find plants that would grow under such conditions and that would resist erosion from the steep slopes. The plants had to establish a nutrient cycle that would allow the nitrogen content of the sand to increase. The most popular mixture in use today is Dutch Westerwolds rye-grass (*Lolium multiflorum* var. *westerdolicum*) with white clover (*Trifolium repens*). Seed, mixed in water with an organic mulch, is sprayed from a slow-moving vehicle directly on to the sand. Various mulches were tried. Some, such as peat and chopped straw, were of less value than others with long fibres, such as cotton or cellulose waste. Fully-digested sewage sludge is also used, with considerable success. Chemical stabilisers were tried, but were found to contribute nothing. Fertiliser cannot be mixed with the seed and mulch. Even small amounts of nitrogen and phosphorus inhibit the clover. Fertiliser is used either in a slow-release form, or is added about six weeks after the clover is established, continuing until the nutrient cycle is secure. The Westerwolds grass establishes itself rapidly, but then dies down and is replaced by more aggressive invading species.

Endangered sheep add fertility

With no soil fauna, organic material tends to lie on the surface rather than being incorporated into the sand. The solution to this problem was to introduce sheep. Not only do they trample detritus into the surface sand, they encourage the grass by grazing, and add nutrient in the form of their urine and faeces. The animal chosen for the task was the Soay, a pretty Hebridean sheep that used to be an endangered breed. Today about 650 of them graze the sand tips and there are also about 40 South Devon ewes. The Soays stay outdoors



J. Burton/Bruce Coleman



G. Dore/Bruce Coleman

Soays (left) help to increase the fertility of the tips that have become their home. Ungrazed tips are soon colonised by nettles and other plants

throughout the year and need little attention. They will not eat clover, which means they contribute to the fertility of the pasture without detracting from it. They look after themselves, and are not afraid even of dogs. If seriously threatened, a Soay ram will attack! There is sufficient pasture now for up to 3000 sheep, and there has been talk of introducing a Scottish blackface flock. But the numbers can increase only as fast as fencing, which is expensive.

The "stepped pyramids" may be characteristic of the Cornish landscape, but they cannot be said to sit naturally in it. Once work on them has finished, and vegetation is established, their shape can be modified. Penrose "hill", for example, looks entirely natural, its gently rounded form grassed completely and grazed by sheep and cattle; yet not long ago it was an overburden tip. Recently tips have been shaped as they are made, so their later landscaping is easier and they are less intrusive in their early years.

Some pits have been filled, especially those that are close to villages. Properly drained and topped with about 2 metres of sand, they have become playing fields or ornamental gardens, with the seed-mulch mixture being spread by a machine much like an asphalt spreader. The areas involved are small, but there used to be many unsightly corners in the mining villages near St Austell and, by making improvements here and there, English China Clays has done much to make life more pleasant for local residents.

Where the land is badly scarred and broken, the simplest treatment is to plant trees and produce small patches of woodland. Derek Owen likes trees, and his overall scheme is to make landscapes of wooded slopes with open pasture on the higher ground. The company has its own tree nursery, stocked originally with plants grown from seed collected locally. Alder is used on the wetter ground, and some sitka spruce have been planted, but never in monocultural stands: the woodland is always mixed. Tree lupins (*Lupinus arboreus*) are used to fix nitrogen among the trees. They grow into large bushes, then die as the tree canopy closes.

Where the reclaimed tips are not grazed by sheep, plants enter readily. Some, such as stinging nettle, rosebay willow herb, broad-leaved dock, dandelion and bramble, are typical

Modern sand tips, built in stages, can be transformed into gently rounded hills that blend in with the natural landscape



Derek Owen, the landscape surveyor who masterminded English China Clay's restoration programme

of disturbed land, but there are many others. Yarrow grows on the tips, and bugle, ling and heather, carline and spear thistle, foxglove, rushes on the wetter ground, birdsfoot trefoil, ribwort, great plantain, silverweed, tormentil, self-heal, meadow buttercup, sorrel and sheep's sorrel, ragwort and scabious. A little broom has been planted, but not much because it is a fire hazard. Common gorse is there, but also the less common (and native) dwarf gorse, or western furze, and willow and pedunculate oak have appeared.

No one has attempted a census of the fauna, but there are many common birds and the vegetation must supply food for many insects, so it would be surprising if the insectivores and small rodents were not colonising, and thereby attracting predators. The soil fauna may also be developing, as a topsoil accumulates. It used to take centuries to build up a centimetre or two of topsoil. On the tips it takes just a few years.

Shepherd on the spoil heap

The Soays are making the tips their own. They even help on the shaping, by kicking out small platforms on which they lie in summer. They are culled, and the delicious meat finds a ready local market. The skins are sold to the rug trade and in future they may be used for making garments. Although they are strongly independent, from time to time the sheep must be rounded up or moved, and today English China Clays employs a part-time shepherd. He has had his problems, trying to manage animals that have no fear of his dogs and can clear 1.5 m with a standing jump.

The agricultural use of the reclaimed land does not end with the sheep. The mica dams dry out to form white plains, with a consistency of putty. Derek Owen tried many legumes to find one that would grow, and fix nitrogen for other plants, in the all-but-sterile conditions in these mica lagoons. It is a strange sight now to see vegetables growing on the pure white substrate. This year, grass grown on the mica has been conserved as silage for winter feed, and acceptable yields of wheat and barley grown on sand.

So far about 400 hectares of land have been reclaimed and the programme is to continue for as long as is necessary. In a sense it has become a victim of its own success, for the company is still criticised for the derelict land that remains. Some of this land is not its responsibility, for while it is by far the biggest operator in the china-clay industry it is not the only one, and there are mica dams, abandoned pits and spoil tips where neither the writ nor the sheep of Derek Owen run. Other land does belong to the company, but it is being worked still and eventually will be restored. Its area is much smaller than it was, but the landscaping of the reclaimed areas has been so successful that they merge into the surrounding countryside and become "invisible". Local people know the

history of their surroundings well enough, but visitors may not recognise land that has been reclaimed unless it is pointed out to them. They see only the work that is still to be done.

Lessons have been learned during the reclamation programme that can be applied widely elsewhere. Experiment continues, of course, but the difficult problems have been solved and their solution has altered some older ideas about the restoration of industrial wasteland. Conventionally, for example, topsoil is used to supply the substrate in which plants are grown. It is difficult and expensive to move and to store, and soluble nutrients are lost from it quickly. In Cornwall it has been found to be unnecessary. The topsoil overburden can be dealt with as a disposal problem of its own, and vegetation can be established quickly and cheaply on the remaining waste material, provided the pioneer plants are chosen carefully and establish an effective and stable nutrient cycle.

The process takes much longer than the two years of "aftercare" written into many restoration contracts. Ten years at least may be needed.

If reclaimed land is to be made part of a living landscape it is not enough simply to plant vegetation on it. It must be shared, and its final use must be decided at an early planning stage. The choice of uses may be wide. In Cornwall, some of the most intractable of wastes can be used for agriculture, for ornamental gardens and playing fields, or be converted to semi-natural habitat, as woodland or heath. In time there is no reason why some areas might not even aspire to the status of nature reserve. Even toxic wastes might be reclaimed in this way, provided they are treated to make them safe.

If the "White Alps" can be restored, surely no industrial landscape is beyond redemption. □

Michael Allaby is a freelance writer on environmental matters.

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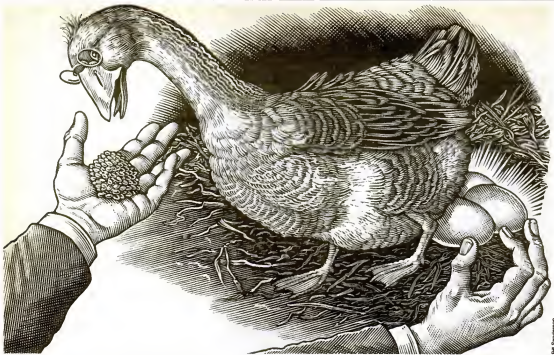
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BP backs revolutionary research

Britain's largest company is spending at least £2 million in a novel search for new products and methods. Scientists and engineers can apply for long term funding to open up new research directions

Donald Braben

YOU ARE a researcher. How do you persuade the research council or the science supremo of an industrial research outfit to fund your brilliant new ideas? Questions similar to this one seem to occupy an inordinate amount of the energies of scientists all over the world, not to mention grouches about the shortsightedness/injustice/lack of imagination of a straight thumbs down to a researcher's pet proposal. "New ideas are being stifled by bureaucracy", is the standard grouse over a beer or gazing into a test tube, along with more detailed criticisms of why the system doesn't work.

But what would you do if you woke up one morning to find that suddenly you had the chance of starting with a totally clean slate, and putting together your own system. That's exactly what happened to me, three years ago, when the largest company in the United Kingdom, British Petroleum, took me on to run a new venture. BP had decided to add a new dimension to its research interests. Although the long-term aim of the "Blue Skies" project is to lead to new horizons and drum up major new business for BP outside its present main activities, the nature of the research was not specified—only that it should be based in universities and similar institutions at home or abroad.

And so the Blue Skies project—or to use its more prosaic name, the Venture Research Unit, got off the ground. Its philosophy is still developing, but it's now a very concrete operation—£2 million has already been committed to 18 research projects in the UK, the Netherlands, Eire and the US, and we are still adding projects to the list. BP gave me flexibility and freedom as well as two colleagues, Derek

Barker and Keith Cowey, to make up the Venture Research Unit. We are treating the subject like an experimental science—that is suck it and see, being prepared to modify our ideas as we learn more about the process of innovation.

The important question was how should our great freedom and flexibility be used? Complete freedom is not necessarily a good thing, as the newly retired often discover, nor is it easy to use effectively. For many people it seems to mean freedom to do what someone else has done before with some success, and initially this seemed to be the best course to take. So in our search for innovation we decided, without much conviction, to concentrate on a few of the rapidly developing fields, that is on the current fashions such as biotechnology, new materials, lasers and the like, but the emphasis was to be on supporting the research whose main objective was to improve understanding in these fields rather than on products.

This choice of emphasis turned out to be the first valuable step along the long road to defining a viable approach to Blue Skies research. The most obvious feature of innovation is that it always comes with surprise. The major innovations and discoveries of the 20th century such as transistors, penicillin or nuclear power could not have been predicted before their time nor do their stories have much in common except the research which led to them could not have been directed towards their discovery. On the other hand, as Pasteur so wisely pointed out over 100 years ago "fortune favours the prepared mind", and so we thought that a theme based on *understanding* the science rather than say on product

development ought to tip the balance of probabilities in favour of the unexpected innovation we are looking for.

However, our initial policy of focusing on some of the growth areas (the usual fashionable clasp on one outspoken senior professor described it) was a source of constant nagging doubt. Most of these fields are already well populated, excessively so in some cases, and our late entry would be unlikely to make a substantial impact.

So we tried to look deeper, particularly for a way of applying our money where its unique lack of strings could help add most. The eminent scientists on the Venture Research Advisory Council—the Chairman Sir James Menter, Sir Rex Richards, Sir Hans Kornberg and Professor John Cadogan—contributed their expertise to this slow painstaking process as did my colleagues in the Unit.

What is our new strategy?

We try to bring about an environment in which creativity can flourish by selecting people of outstanding ability who wish to work on a problem of their own choice and for which we can imagine a substantial outcome. This strategy implies that we should have no preconceived ideas about the research we should support and that we should concentrate on deriving the criteria against which we should assess proposals which, on the balance of probabilities, might stand the best chance of success.

Briefly summarised, our scheme is likely to be attractive to those researchers who have reached a stage in their careers, either young post docs or those of more mature years, where they want to try something new or unconventional. As many readers will know, most research in academic institutions and also in industry is concerned with the development of incremental advances; that is, its essential framework is well established but the details are not known. Now although evolutionary research can lead and indeed has led to major breakthroughs, it is so unlikely that it would not be sensible to concentrate on this type of research, for which in any case there are many potential sources of funds. A better approach seems to be to look for the research with prospects of being revolutionary, that is of establishing a new framework, or deriving new bandwidths.

Of course, it's also impossible to predict revolution, and we can only recognise the revolutionary character of a particular development after it has happened. This is the essential dilemma of Blue Skies research and of course there can be no direct solution. However, we believe that those who are determined to understand a phenomenon and to follow their research and their intuition wherever they may lead, are on the balance of probabilities, perhaps more likely to come up with new knowledge than those who are trying to solve a narrowly defined problem or to develop a product. Similarly, if we can imagine that the research could lead to a diverging range of possibilities we believe that it is much more likely to lead to unexpected discoveries than would be the case if researchers were focused on a well specified target.

The character of the research is also important. Much has been written about the need for multi-disciplinary approaches but we would prefer to support those who view their research problems without constraints on scientific discipline. The central theme of the Unit's philosophy is that there is only one science, no matter how finely disciplines have become subdivided (largely for administrative purposes)

over the years, and so we look for those research proposals which are naturally and freely expressed. After all a molecule is indifferent to the discipline practised by its observer, and it will indulge in physical, chemical or biological processes (or any combination thereof) according to the circumstances; *à la carte* options are strictly forbidden.

However, we must not forget that we are trying to spawn new industrial or commercial opportunities, and although researchers are encouraged to explore the full potential of their ideas whatever the outcome, it must be conceivable that the research could lead to a significant opportunity for investment within a reasonable timescale; say a decade or so. This criterion means that a great deal of fundamental science such as elementary particle physics or astronomy would not qualify for our support; but it does not mean that we avoid

contact with scientists working in these fields. There may well be important indirect contributions they can make, if they wish to. For example, the sophisticated mathematics used in cosmology say could find wider application (particularly in engineering—but see later). But, it is equally important that the imagined outcome should not be set as a goal; it is not possible to imagine the unexpected however rich our imaginations, and so the possible pot of gold is used to justify our involvement.

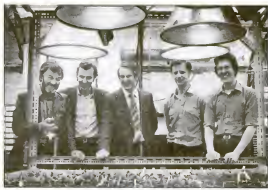
Those readers who have applied to traditional funding organisations for support will know that their ideas will

be subjected to independent "peer" review; that is, comments are invited (often in secret) from those working in related fields on the quality of the proposed research and its chances for success. It seems to us that this approach would not work where the ideas are essentially novel or controversial. In these circumstances, whenever we need independent opinion, we look for confirmation of our confidence in the credibility of the credibility of the people concerned; we then back their judgement on the likelihood of success, for they will be staking part of their careers and reputations on the outcome. We try to do this by inviting proposers to nominate their own referees—not many—one or two will usually suffice. Of course the more reputable they are the better! We find that this system works well: it avoids some of the problems arising from personalities, and it seems to be welcomed by all concerned even though self-selected referees do not always say what they are supposed to!

We are likely to be attracted by people who have recognised a general and fundamental problem as opposed to a specific one. Obviously we cannot know the outcome of a new project, so let's consider how we might have proceeded 31 years ago.

An example of research with specific objectives might have been the measurement of the electrical conductivity of insulators like germanium. Since the conductivity is very low, precise techniques would need to be developed for its measurement, which may present very difficult problems to be overcome, but the research programme would be complete once the relevant information had been obtained. On the other hand, we might have backed research aimed at understanding why some materials are insulators and why for example, adding small quantities of certain impurities to these materials has a dramatic effect on their conductivity.

Although all this may be a reasonable prescription for Blue Skies research in science, it would seem to have little meaning



David Walker (left) and his team at Sheffield University are looking at how to control and exploit photosynthesis

JERRY MASON

for engineering. It is absolutely vital in any activity in this field that there must be a clearly specified objective, which would therefore seem to rule out the Blue Skies approach outlined here.

Maybe not; but before explaining, I should say something about our definitions. Just as we define science to be any activity directed towards understanding any phenomenon or process in nature, we take a similarly broad-brush approach to the definition of engineering. Of course, the disciplines of science and engineering are not always sharply separated. There is inevitably some overlap; nevertheless the intrinsic character of much of the activity in these two fields is quite different. Although nature is infinitely diverse and the techniques and approaches used for its study are widely varied, a most obvious feature of science seems to be that it is concerned with the dismantling of superfluous structure, and the description of nature's many facets in the simplest possible terms. On the other hand, engineering seems to be concerned with the intellectual obverse of all this, that is with assembly or synthesis.



Colin Caro (left) and R. M. Barrer of Imperial College, London who are looking at the way fluids flow through deformable porous organic materials like those found in living systems

In our framework, engineering begins when understanding of the appropriate science has reached the point where predictions can be made with a degree of confidence, and opportunities for exploitation have been identified. The science may be old and well established as in mechanics, or novel as in biochemistry. In any event an engineer must know his science and particularly the limitations on that knowledge but in general his scientific literacy does not help him either to design a product or to write a computer program to control the product's function. Such tasks as these can only be carried out when the engineer has also derived methods of organising his knowledge on a wide range of subjects such as efficiency, reliability, safety, economics, elegance, marketability etc. in a coherent way.

Engineers may be highly innovative in this work even though no new (natural) science is involved as the Japanese and others have shown in recent times. However, in general, the methods traditionally used by engineers to manage and control the large number of complex and interacting factors contributing to design tend to be qualitative and involve value judgements, the lessons of experience and ultimately pragmatism. The qualitative approach may be acceptable for small systems, but for more substantial enterprises it would be surprising if the development of more disciplined and rigorous approaches, say through the wider use of mathematics, would not be more successful and lead to new types of opportunity.

I do not mean to imply that engineering should or could be an exact discipline. It can never be so mainly because engineering almost invariably involves compromise (and people!). Of course, engineers use mathematics extensively, but its use seems to be restricted to the final stages of the



Professor Edsger W. Dijkstra and Netty van Gasteren of the University of Eindhoven will be working on ways of identifying and dealing with unnecessary complexity in engineering, especially computing

design process, such as for the detailed calculation of stresses in structures. However, they key to the avoidance of uncontrolled complexity in any engineering domain may be to go for a complete and as rigorous as possible a description of the problem in hand before any detailed calculations are made on the precise properties of the postulated design. In the language of computer software say, this would mean careful attention to the derivation of the algorithm before a line of code is written. Mathematics can play a role in this stage too, for example through the use of mathematical logic.

The application of sophisticated mathematical techniques and other Blue Skies approaches in engineering may come about through collaboration, but the important point to realise is that once formal or rigorous methods have been developed and applied successfully in one field of engineering, they may be applicable, suitably modified, to others and perhaps lead to more reliable specifications and designs in general. Improvements in reliability could open up new markets. This has already happened in microelectronics and the last few years have seen a revolution in this respect. What if we could precipitate a revolution in engineering design generally? So much for theory—what about the practice?

All the research programmes have come from approaches made to the Unit and have involved extensive discussions, sometimes over a long period, but not for bureaucratic reasons. The derivation of original research proposals is never easy, but to participate in their creation and perhaps to stimulate or catalyse them can be very exciting when there are no artificial restrictions on what can be done. For example, David Walker and his colleagues at the University of Sheffield approached us because they wanted to take a new look at photosynthesis. This group has long been noted for its breadth of vision but nevertheless it took them some time to realise the unique advantages of the photosynthetic "mechanisms" in plants and thereby to derive what may be an original approach to the problem.

Briefly summarised, these are first, that photosynthesis may be "switched" on and off reversibly; and second, that its behaviour is highly modular in that the complex series of reactions that make up photosynthesis can be reviewed as going on inside a number of "boxes", each fairly distinct and separable from each other—the light-harvesting mechanisms, the conversion of the light energy to ATP, the use of ATP to make carbohydrates and so on. Plants are normally under

some form of stress—heat or light stress are two of the many forms—but nevertheless plants are generally healthy, from which we may conclude that nature is continually carrying out a delicate balancing act among the contributing reactions making up the complete photosynthetic “machinery”.

What if we were to look therefore at photosynthesis through the eyes of a control engineer? The idea of biology having important lessons for control is not new, but in this case the Sheffield group would have the willing and enthusiastic support of two control engineers—Harry Nicholson and Vince Fernando—who were just as excited about the prospects for collaboration as their new biological colleagues.

The group agrees that the discussions with the Unit were a key element in the formation of the collaboration, but the original idea came, as it must do, from the researchers. As for the Blue Skies criteria, we may imagine that a better understanding of photosynthesis either may lead to, say, better synthetic devices; or to new insights into control engineering, leading say to advances in the control of complex fermentation processes. Or the research could go anywhere and lead to the unexpected!

Still open to more new ideas

Of course we only support a tiny proportion of the proposals put to us, mainly because it is very difficult to create new and revolutionary approaches. Research contributing to existing areas may be funded from a variety of sources and so we tend to avoid it. On the other hand, the probability that we would go for a genuinely original idea may be very high indeed.

So far we have decided to back the work of 80 scientists and engineers. Their interests span almost all the conventional disciplines. Since we have no preconceived ideas about research fields, the programme is not coherent or balanced in terms of disciplines and there are very few areas where interests overlap, as was intended. Nevertheless, those participating in the programme have a common intellectual goal in that their primary concern is to understand rather than to develop. We believe that this common factor is so important that during the past year or so we have experimented in ways of bringing the participants together to discuss their ideas and to foster the creation of a spirit of community. However, the languages of science and engineering have become so specialised that communication across the disciplines is difficult to achieve, but there seems to be no reason in principle why this must be so as the concepts are universal.

If we can develop a conceptual language therefore, there may be important advantages for the scheme. There are encouraging signs that our experiments in communication are starting to yield some useful results and we intend to continue with them in the future.

The Venture Research scheme is still expanding: we are still looking for new proposals! The procedure is very informal; a short note or even a telephone call will suffice in the first instance as we are mainly interested in concepts rather than with detailed descriptions. There are few restrictions on the type of support we can offer but the important feature is the idea; once that is accepted we will help the researcher in whatever way may be appropriate to bring his idea to fruition. In keeping with the spirit of the Blues Skies approach I should also point out that in the absence of clearly identified industrial or commercial possibilities (as opposed to imagined ones) the research would not be subject to the constraints of confidentiality. There are no deadlines and we will welcome your ideas for novel research now, or, I hope, at any time in the future! □

Dr Don Braben began his career in nuclear physics research and later gravitated to the science policy world, doing a stint in the Cabinet Office. He went on to plan for the Science and Engineering Research Council and has been scientific adviser to the bank of England.

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Chemical matrix freezes fleeting molecules

The identities of chemical units that normally exist for less than a microsecond are important clues to how reactions take place. Researchers can trap them in frozen gases and study them at leisure

Paul Breeze

WHY IS lapis lazuli blue? A chemist would say that the colour comes from sulphur molecules trapped within the crystalline matrix of the stone. The molecules each contain three atoms of sulphur, and are negatively charged: the structure that encases them consists of linked cages of aluminium, silicon and oxygen atoms. What makes this gem fascinating is that S_3 molecules are normally highly reactive, surviving only a fraction of a second in solution. Trapped in lapis lazuli's rigid cages, however, they are unable to react, and so they sit there absorbing light from the red wavelengths of the spectrum.

This absorption gives the spectacular deep blue that has made it a popular material for ornaments since the Middle Ages. Lapis lazuli is an elegant natural example of a rogue molecule trapped and isolated in a matrix. This phenomenon of matrix isolation is not just a pretty toy: it can be exploited as a tool as well. The chemist can use just such a matrix to trap a species whose normal lifetime is just fractions of a second, and subject it to a longer, closer scrutiny than would otherwise be possible.

Sir George Porter, of the Royal Institution in London, and George Pimentel, then associate professor of chemistry at the University of California at Berkeley, began work on exploiting matrix isolation in 1954.

What matrix material would be sufficiently stable towards these very reactive molecules? A good choice is one of the inert gases: neon, argon, krypton, or xenon. Historically, these gases were called inert because it was thought they did not form any chemical compounds. Chemists now know this is untrue, but they remain the most unreactive substances.

The gases solidify between 25K and 120K, so liquid helium or liquid hydrogen are used as refrigerants to prepare a solid matrix. This fixes the temperature of the matrix to between 4K and 20K. The matrix is formed on a disc of a material such as caesium iodide, chosen for its transparency to infrared (IR), visible and ultraviolet (UV) light. Scientists then use spectroscopic techniques to identify the isolated fragments. They conduct their experiments in a vacuum, as air freezes at these low temperatures and would contaminate the samples.

The next problem is how to trap the reactive molecules in the matrix. There are two principal routes. The first is to generate the molecules as gases, mix them with a large amount of argon and freeze the mixture. The alternative is to generate the molecules within the matrix. The simplest way is to freeze into the matrix a precursor that decomposes to the desired fragment when irradiated with light.

The making and breaking of chemical bonds is associated with an energy barrier. At normal temperatures most molecules jostle with enough thermal energy (as kinetic, vibrational and rotational energy) to overcome this barrier. So, molecular fragments, formed by irradiating a precursor,

would instantly recombine. Near absolute zero, however, molecules have much less thermal energy. Therefore, even if two reactive fragments were side by side in a solid argon matrix, there would not necessarily be enough thermal energy to overcome the barrier and reform the precursor.

To illustrate this, consider a group of compounds that has provided matrix isolation chemists with years of fun—

the transition metal carbonyls. These are simple combinations of metals like chromium, tungsten, iron or nickel, with carbon monoxide. If chromium hexacarbonyl, $Cr(CO)_6$, is mixed with another chemical, X, that easily adds onto chromium, and irradiated with UV light, a mixture of chromium compounds containing both carbon monoxide and X, are formed.

Light could cause $Cr(CO)_6$ to lose a carbon monoxide molecule, forming a reactive fragment that grabs the next molecule it bumps into. This is quite likely to be X—hence our mixture of compounds.

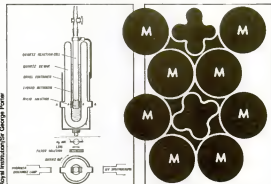
We can test this theory by using matrix isolation and then employing standard techniques such as in the study of stable molecules.

Chromium hexacarbonyl is a symmetric molecule with a strong infrared absorption due to stretching of its six carbon monoxide groups. Jim Turner, now at Nottingham University, and his group condensed $Cr(CO)_6$ into a matrix with a large excess of argon and irradiated the whole with UV light. The IR spectrum from the matrix shows two new peaks, which careful analysis indicates to be chromium pentacarbonyl, $Cr(CO)_5$. This must have been formed from $Cr(CO)_6$, by light-induced loss of a carbon monoxide molecule.

Besides the new IR absorptions, $Cr(CO)_5$ absorbs light in the UV/visible region. This absorption is associated with electronic energy levels in the molecule's chemical bonds, and the position of the absorption lines depends on the matrix material. This means that an atom or molecule of the matrix is occupying $Cr(CO)_5$'s vacant position—in other words, bonding to the chromium. For matrix materials like methane, nitrogen, krypton and xenon, this is not too surprising. But to suggest that argon and neon form chemical bonds almost amounts to chemical heresy. The implications of this incidental finding are still not fully worked out.

Even more interesting chemistry has come out of the matrix isolation work on metal carbonyls. Bombarding metal carbonyls with electrons in a matrix results in the production of negatively-charged ions. These can be studied free of interference from positively charged counter-ions—something chemists normally find extremely hard to achieve.

Malcolm Green and Robin Perutz at Oxford University have harnessed matrix isolation work in the quest to find a simple way of activating methane, a process of enormous commercial interest because of the vast stores under



Sir George Porter's first matrix isolation experiment (left). Section through a matrix showing trapped intermediates (right)

the North Sea. The idea is to find a molecule that will attach itself to methane and then react so that the methane is converted into a product that is useful as a fuel (*New Scientist*, vol 97, p 441). No such molecules are known, but Green made a tungsten compound, called bis (cyclopentadienyl) tungsten dihydride, that will attach itself to certain hydrocarbons. This molecule has a central tungsten atom surrounded by two five-atom carbon rings and two hydrogen atoms. Under the influence of light, it reacts via an intermediate.

Perutz froze the compound into an argon matrix, and irradiated the molecule with light. The spectrum he detected signalled the presence of a new molecular species. Light had caused the parent molecule to lose its two hydrogen atoms and rearrange so that the two carbon rings sandwiched the tungsten atom.

The scientists realised that one intense IR absorption line was not a molecular vibration but a low energy electronic transition. This clue led to the realisation that, in its lowest energy form, the intermediate has two bonding electrons in different energy levels. This is probably the reason that the molecule forms two new bonds when it reacts with a hydrocarbon, one with carbon and one with hydrogen. Unfortunately, the tungsten compound will not react with methane, so the problem of activating it is not yet solved.

Organic chemistry has also profited from matrix isolation techniques. Once again methane serves as a good example. Burn it and you get carbon dioxide, water and a lot of heat. How does it happen?

Methane's four hydrogen atoms are replaced by two oxygen atoms to give carbon dioxide. The hydrogens are probably removed one by one: first, the methane loses a hydrogen atom to give the methyl radical, $\text{CH}_3\cdot$, and extremely reactive fragment. The problem is to prepare the methyl radical, trap it, and to study it.

Chemists prepare the methyl radical by decomposing methyl iodide, CH_3I , in a hot platinum tube and trapping the fragments in an argon matrix. This gives an IR spectrum containing absorptions belonging to methane, ethane, ethylene and three new peaks assigned to the methyl radical. What is more the new structural information shows that the methyl radical's expected pyramidal shape relaxes into a planar structure.

An important principle applies to the preparation of molecular fragments—the principle of the "good leaving group". Put simply, if you wish to make a reactive intermediate, incorporate it into a molecule that contains something which is stable on its own. When excited by heat or light, the stable part splits off leaving the desired fragment.

Iodine is a good leaving group—chemists use methyl iodide to make the methyl radical $\text{CH}_3\cdot$. Molecular nitrogen, a very stable molecule, is even better. So is carbon dioxide. For example, diazirene, $\text{C}_2\text{H}_2\text{N}_2$, isolated in an argon matrix, and irradiated with UV light, loses nitrogen to give the methylene diradical. This is an interesting intermediate because its carbon atom uses only two electrons for bonding, the other two electrons occupying separate orbitals. The intermediate thiirene, $\text{C}_2\text{H}_2\text{S}$, which contains a highly strained triangular carbon-sulphur-carbon ring, was also isolated from a nitrogen precursor. Researchers also managed to trap the ethyl radical, $\text{C}_2\text{H}_5\cdot$, another classic organic intermediate, after preparing it from a precursor containing carbon dioxide.

Matrix isolation has given some surprising results in the study of vapours from molten salts. Salts can be described as a collection of ions held together by their mutual electrostatic attraction. For example, potassium nitrate (KNO_3) is considered as an array of potassium ions K^+ and nitrate ions (NO_3^-). They are not normally thought of as potassium nitrate molecules existing as single entities outside the solid lattice. When chemists vapourised potassium nitrate and trapped it in an argon matrix, however, they were surprised to discover that it contained molecules with the chemical formula KNO_3 .

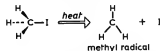
This molecule has two possible structures, one within the

potassium atom bound to a single oxygen atom and one in which it is attached to two oxygens. IR spectroscopy on its own cannot distinguish between the two. The problem was resolved using a trick called isotopic substitution.

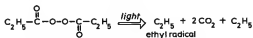
The most abundant isotope of oxygen, O^{16} , has an atomic mass of 16 units made up from eight protons and eight neutrons. Minute traces of other stable isotopes occur alongside. O^{18} , for example, with an atomic mass of 18 units, has two extra neutrons. If one of the ordinary O^{16} atoms in KNO_3 is replaced by a heavier O^{18} atom, all the molecular vibrations involving that atom slow down, changing the IR spectrum. This method reveals that potassium is bound to two oxygen atoms in KNO_3 .

In this brief survey of matrix isolation I have avoided one vital issue—the effect of the matrix on the isolated molecule. Given the choice, most scientists would prefer to study mole-

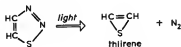
Organic reactions studied by matrix isolation



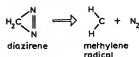
Methyl radical prepared in the gas phase and trapped in an argon matrix



Ethyl radical with carbon dioxide as the leaving group



Thiirene prepared in an argon matrix



Methylene radical prepared from diazirene

cules in the gas phase where they are widely separated and do not interfere with one another. The information obtained from spectroscopic studies can then be directly related to unperturbed individual molecules. Whilst matrix isolation attempts to reproduce this situation, the target molecules are in intimate contact with the matrix material. The effect this has is illustrated once again by chromium hexacarbonyl.

In the IR spectrum of this molecule already mentioned there is one strong absorption and a much weaker one associated with it at a slightly different frequency. Not all the isolated molecules are in identical cages in the matrix and the effect is to shift the frequency. But, as with the wealth of other experiments that matrix isolation has made possible, the drawbacks are insignificant compared with the value of the techniques as, sometimes, the only tool with which to examine the inner workings of chemical reactions. □

MONITOR

Firm evidence for non-cosmological redshifts

THE most conclusive evidence, to date, in support of a physical link between objects with significantly different redshifts. That is what Jack Sulentic, of the University of Alabama, claims to have found from a study of previously unpublished photographic plates of the galaxy NGC 4319 and the object Markarian 205. If his claim stands up, it establishes that at least part of the redshift in the light from some astronomical objects is not produced simply by their recession from us in the expanding Universe, and that blunts the cutting edge of the most important tool in observational cosmology.

Arguments about the nature of the redshift in the light from extragalactic objects (objects outside our own Milky Way galaxy) have continued with more or less vigour for decades. It is generally agreed that these redshifts are caused by the expansion of the Universe. This expansion stretches spacetime between us and the other galaxies, and stretches the light from those galaxies at the same time, making its wavelength longer and shifting features in the visible spectrum towards the red. This is not a Doppler shift—it is caused not by movement of distant galaxies through space, but by the expansion of spacetime. However, it is a very similar process to the one by which the pitch of the siren on a fire engine is deepened as the vehicle rushes away from the listener.

Few astronomers, if any, doubt that this process explains the redshift in the light of ordinary galaxies, and because observations of nearby galaxies (whose distance can be measured in other ways) show that their redshifts are proportional to their distances from us, it is assumed that measuring the redshift of a very remote object, whose distance cannot be measured directly, tells us how far away it is. Without this redshift/distance relation, it would be impossible to estimate reliably the distance to most of the galaxies we observe.

But there is a simmering controversy concerning the application of the redshift/distance rule derived from ordinary galaxies to quasars and peculiar galaxies. It is tempting to assume that the same rule applies, but quasar redshifts are, in some cases, very much bigger than any measured galaxy redshift, so the assumption involves considerable extrapolation. It is this assumption, however, which is the basis of claims that the "most distant" quasars known are upwards of 10 000 million light years away from us, receding at more than 90 per cent of the speed of light.

A few astronomers have raised doubts about this extrapolation from ordinary galaxies to all extragalactic objects. They argue that redshifts can be produced in other ways than through the expansion of the Universe by gravity; by the rapid motion of an object, a true Doppler shift that, thanks to relativistic effects, produces a redshift even if the object is moving across the line of sight; or by other, unknown, means. Perhaps part of the redshift in quasars and unusual galaxies is not, after

John Gribbin

all, due to the expanding Universe.

This has been a minority view for 15 years or more, but one kept alive by the persistent efforts of Chip Arp, of the California Institute of Technology, who has over the years produced a series of photographs which show objects with very different redshifts that are physically connected by streams of material. Obviously, if two objects are physically connected they must be at about the same distance from us, and yet many of these Arp associations include objects with redshifts that "ought" to place them far apart along the line of sight.

One of the pairs identified by Arp is the galaxy NGC 4319 and the object Markarian 205, which lies only 42 arc seconds away from it on the sky, and might be a quasar or a peculiar galaxy. The standard interpretation of their redshifts says that NGC 4319 is receding from us at 1800 km per sec, while the redshift of Markarian 205 indicates a recession velocity of 21 000 km per sec (*The Redshift Controversy*, G. B. Field, H. Arp & J. N. Bahcall, W. A. Benjamin, New York, 1974, p. 46). This is a characteristic pattern—the redshifts of the unusual objects associated with galaxies in Arp associations are always greater than those of the "parent" galaxies. In this case, the difference in redshift of 19 000 km per sec corresponds to a separation of about 800 million parsecs between the two objects, (1 parsec is roughly 3.25 light years). And yet, according to Arp, NGC 4319 and Mrk 205 are connected by streams of material, impossible if they are at such different distances from us.

During the 1970s several teams attempted to refute this claim, arguing that

the connection is a figment of Arp's imagination, that it is an optical illusion caused by the overlap of isophotes (light contours) from the two objects, or that it is an illusion caused by a star or galaxy which just happens to be located between the two objects. Sulentic's analysis rules out all of these possibilities. He has analysed four photographic plates of the pair obtained with the 5-metre Hale telescope, and three from the 4-metre instrument at Kitt Peak, using a microdensitometer of the Jet Propulsion Laboratory to make a detailed survey of the plates. Averages of the 5-m plates, the 3-m plates, and all the plates together show the same results: the "bridge" between NGC 4319 and Markarian 205 is real (*Astrophysical Journal Letters*, vol 265, p. 49).

To Sulentic's surprise, he has also found that the connection can be traced right into the central nucleus of NGC 4319—very much as we might expect if, as Arp has often suggested, high redshift objects are somehow shot out from the centres of otherwise normal galaxies.

This new evidence does not mean that the redshift/distance relation for galaxies has to be discarded. But it does imply the need for caution in making extreme claims about the distances of quasars based solely on redshift evidence, and it does suggest that Arp's evidence concerning other, similar associations should be taken more seriously than has often been the case. Since so much of extragalactic astronomy hinges upon the redshift/distance relation, Sulentic is not exaggerating when he says that understanding the nature of the link between NGC 4319 and Mrk 205 "is surely one of the most important problems facing extragalactic astronomy". □

Ulcer diagnosis at your fingertips

SOME people are more susceptible to duodenal ulcers than others, and the problem for doctors is deciding just who is at risk. New research by C. M. Habibullah and researchers in the Gastroenterology Unit of Osmania University in Hyderabad, India, suggests that the answer may be found in the patient's fingerprints! (*Human Heredity*, vol 32, p. 432).

Many studies have demonstrated that genetic factors contribute to susceptibility to duodenal ulcers. The team at Osmania University investigated the possibility that fingerprint and palmar patterns may somehow act as genetic markers of susceptibility to duodenal ulcers.

They compared the finger and palm prints of 64 healthy adult males and 90

males with duodenal ulcers. They examined fingerprints for arches, loops and whorls, and palmprints for the presence or absence of patterns in the thenar, hypothenar and interdigital areas. Whorls were most frequent amongst men suffering from duodenal ulcers (44 per cent compared with 37 per cent in healthy subjects) and loops were less frequent (51 per cent compared to 58 per cent). In addition, patterns were most frequent amongst duodenal sufferers in the thenar I (21 per cent compared with 3 per cent) and interdigital IV (54 per cent compared with 45 per cent) areas of the palm. If you have many whorls, few loops, patterned palms the chances are you will develop duodenal ulcers. Be warned! □



New technique exposes fake lacquer

A SOLUTION to the tricky problem of distinguishing Oriental lacquerware from modern copies and fakes may at last have been discovered. The analytical technique, which has been devised by A. Burmester of the Technical University of Berlin, may also provide a way of identifying repairs and additions to lacquered objects. It should also help in the dating of new archaeological discoveries of lacquerware in China and other Far Eastern countries.

Far Eastern lacquer, or *urushi*, is a poisonous exudate from the stems of the lacquer tree, or varnish sumach (*Toxicodendron vernicifluum*, also known as *Rhus verniciflua*), which can be tapped like those of rubber trees. The chief constituent of this lacquer (65-70 per cent) is urushiol, a complex mixture of catechol derivatives. There is also a small percentage (5-7 per cent) of polysaccharides, some water (20-25 per cent) and an enzyme, laccase (1 per cent), which acts as the hardening agent. On exposure to air in the presence of laccase, urushiol polymerises and hardens to form a glossy waterproof coating when applied to a solid surface such as wood.

British Museum



Lacquered toilet box—Han Dynasty

The highly specialised craft of lacquer painting and decoration seems to have been invented several thousand years ago in China, where the lacquer tree grows. Lacquer, usually with colouring agents in

it, was used to decorate pots, dishes, various other sorts of containers and toilet articles such as mirrors, all usually made of wood or a textile such as hemp. Fragments of lacquerware have been excavated dating from as long ago as the Shang Dynasty (from about 1700 to about 1000 BC), but it was during the Han Dynasty (206 BC to AD 220) that lacquer painting flourished.

In the past, analytical investigations of Far Eastern lacquer have been hampered because of the complexity of the natural polymer, the small samples of ancient objects available for study, and the lacquer's insolubility in the usual solvents. However, Burmester's first results from the use of pyrolysis mass spectrometry combined with multivariate data analysis offer a more promising line of investigation (*Archaeometry*, vol 25, p 45).

Burmester examined 47 samples of lacquerware in the Linden-Museum in Stuttgart. The samples ranged from modern lacquer hardened in the laboratory to objects from the last centuries BC. In some cases several samples were taken from the same object, but from different layers or areas. Most of the samples were Chinese in origin and were dated. Burmester also included a few samples contaminated with polyethylene glycol, a modern preservative.

The tiny samples of lacquer were progressively heated to about 350°C, ionised and their decomposition products analysed in a quadrupole mass spectrometer. Because of the complexity of the polymer there were more than a thousand peaks or data points per sample but Burmester reduced this vast amount of information by computer clustering.

The mass spectral measurements separated into eight groups. Clearly distinct from the others were the two groups with the modern lacquers and the samples treated with preservative. The remaining six groups clustered approximately in chronological order. Pigments and inorganic primers had little influence on the results. An interesting finding was the similarity of the samples from the same lacquered object, even if they had been taken from a different layer or area. This result, Burmester suggests, indicates that the coatings were applied using lacquer "from one pot" or at least from the same tree.

This last observation may mean that additions, repairs and restorations could be recognised even if they had been carried out with lacquer from the lacquer tree instead of imitations of it. The clear distinction between the old and modern lacquers also offers hope of a means of identifying fakes.

Why natural lacquers separate chronologically so clearly is not yet fully understood. It may have something to do with the different preparation and coating techniques of the lacquer painters. It is also likely that the composition of the lacquer is affected by the age of the tree and when and where the material was collected.

Lead and IQ studies inconclusive

THE uncertainties surrounding the effects of lead on childhood IQs have been emphasised by three new studies. Presented at a recent meeting of the British Psychological Society in York, they suggest that any link between slightly raised lead levels and impaired intelligence is rendered insignificant by other social factors. The studies followed on from research in the US (*New England Journal of Medicine*, p 689) and London (*Developmental Medicine and Child Neurology* vol 237, p 567) which suggested that children with more than 12 micrograms of lead per 100 millilitres of blood had IQs which were 5 to 7 points below the expected value.

The three new studies set out to examine the problem in more detail. Drs Richard Landsdown and William Yule of the Institute of Psychiatry, who carried out the preliminary studies, looked at primary-school children in London and Leeds. Peter Harvey and colleagues at the University of Birmingham analysed blood lead from pre-school children in Birmingham, and Marjorie Smith of the Institute of Child Health studied lead levels in milk teeth shed by London children. Teeth are believed to be a more accurate indicator of exposure to lead than blood, which fluctuates from month to month.

In all three studies, the children were selected to be as representative as possible and in each case they were asked to perform exhaustive intelligence tests and behavioural exercises. At the same time, researchers who were unaware of the results of the lead tests interviewed the mothers, gave them intelligence tests and looked for social factors that might be affecting their children. These factors were then taken

into account in the statistical analysis of the data. It proved a complex process to eliminate variables that were related to intelligence without removing any that might be directly related to lead. Harvey's group, for example, found that peeling paint in the home related to lower IQ, but that it was nothing to do with lead in the paint, relating more probably to the influence of the parents. One of the few factors mirroring lead levels was age of the house, in inner cities often relating also to lead water pipes and old lead-based paint. To be sure they were not removing the very effect they were looking for, the researchers divided the children into groups on the basis of their lead levels. Thus it was possible, for example, to compare children with the same amount of lead but from different social groups. By the time all these factors had been taken into account, any link between lead and impaired intelligence faded into statistical insignificance.

Each research group came to a broadly similar conclusion: that if there is any link between lead and IQ, it is totally masked by much more powerful social effects. It is a conclusion that must have been popular with the Department of the Environment which funded two of the studies. It eagerly and uncharacteristically announced the results two days before the conference. At the same time, the findings are sufficiently inconclusive for members of CLEAR, the Campaign for Lead Free Air to continue to battle for lead-free petrol. Everyone presenting data at the conference was careful to point out that they were not saying that lead is safe, even at low levels, but the "don't knows" do not form a powerful lobby.

Lymph nodes act as hearts for tissue fluid

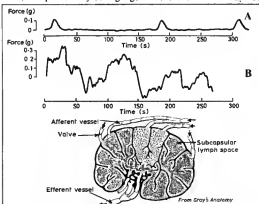
THOUGH William Harvey's discovery of the circulation of the blood was a great medical advance, it now seems self-evident to anyone with an understanding of plumbing. By contrast, the movement of lymph, the fluid that bathes the tissues, is something of an enigma and is still not completely understood.

Now Dr A. Noyan and colleagues from Hacettepe University in Ankara have discovered that the lymph nodes (small swellings) found at intervals along the lymph vessels act as tiny hearts, pumping lymph up from the extremities of the body towards the neck, where it enters the venous circulation (*Journal of Muscle Research and Cell Motility*, vol 4, p 103). The mechanism is so effective that in the human body a partial vacuum of 6 mm Hg exists in the tissue spaces from which the lymph originates.

One of the main tasks of the lymphatic system is to top up the blood with fluid and proteins lost at the capillaries (arteriovenous junction). Most of the material which flows out under pressure from the capillaries is returned from the tissues by osmosis; by virtue of the high concentration of plasma protein in the blood and the sparsity of proteins in tissue fluid. However, there is a net outflow of as much as 10 per cent and it is this "lost" fluid which is drained by the lymphatics and returned to the circulation.

The lymph ducts are divided into vessels by flap valves. It is well known that each vessel contributes to movement of the lymph by contracting once every 6-10 seconds in response to being gorged with

fluid from the vessel upstream. These findings tie in with the regular spontaneous contractions which are observed in smooth muscle. Skeletal muscle also plays a part in propelling lymph, by massaging the ducts, particularly during vigorous exercise.



Regular spontaneous movements of lymph nodes from a calf (A), contrast with those from a guinea-pig (B). The diagram below shows a generalised lymph node

Until recently no one seems to have considered that in addition to filtering lymph, the fluid may also be pushed along by the lymph nodes—despite these structures being the most prominent features of the system. They are distributed around the body at, for example, the groin, the armpit and the abdomen. Noyan's work shows that lymph nodes excised from calves and goats exhibit regular spontaneous movements. Lymph nodes from sheep show less regular movements.

The statistical techniques of time series analysis (autocorrelation functions and power spectra) enabled at least three low-frequency components of lymph-node movement to be recognised, though they may not all be active at the same time. The frequencies lie within ranges which are of the order of one cycle in 10, 20 and 60 seconds.

Further experiments with lymph nodes from guinea-pigs produced movement traces which did not respond to this analysis. The peaks of the calculated power spectra (which demonstrate the most likely component frequencies) were not distributed consistently. The experiments found, however, that when the guinea-pig lymph nodes were stretched for 100 seconds, and a related statistical method (transient response frequency characteristics analysis) was applied to the resulting stretch movement, three rhythmic components could be identified. Furthermore, the frequencies evoked by stretching the nodes were within the ranges of the frequencies of the spontaneous movements observed in the lymph nodes from the other animals.

Dr Noyan and his colleagues believe that the act of stretching coordinates the spontaneous movements of the smooth muscle of the lymph node, a process they call frequency stabilisation.

They suggest that engorgement of the lymph nodes with fluid evokes frequency stabilisation. This causes the nodes to contract regularly, thereby propelling the lymph around the body. □

Marine plants as climate regulators

FLUCTUATIONS in the amount of atmospheric carbon dioxide, which controls the strength of the "greenhouse effect", may be driven by changes in marine biology. The concentration of carbon dioxide in the atmosphere, rising today at a rate of about 1 part per million per year, and standing at around 335 ppm, plays an important role in determining the surface temperature of the Earth, because the gas traps infrared radiation. Several studies have shown that the concentration of carbon dioxide was as little as half the present concentration at the peak of the latest Ice Age, but it has not been clear if this is cause or effect. Now, M. B. McElroy, of Harvard University, has found an explanation involving the input of fixed nitrogen to the oceans.

Nitrogen fixed in the form of biologically useful compounds is a limiting factor for photosynthesis. The more nitrogen they have available, the better marine plants will grow, and as they grow they take up carbon dioxide from the atmosphere. This carbon dioxide is first transformed to carbonates, and incorporated in the shells of sea crea-

tures. These later die and so the carbon dioxide eventually finds its way to the sea floor as sediment.

But it takes hundreds of thousands of years for these processes to turn the sediments into carbonate rock, and meanwhile biological changes, it now seems, play a key role in determining the fluctuating carbon dioxide balance. In particular, the timescale for upwelling ocean currents to return biological material to the surface, where it can be "denitrified", is a few tens of thousands of years. So this is the natural timescale on which to find biologically modulated climatic changes—and it is also the timescale typical of changes from Ice Age to interglacial and back again to Ice Age.

McElroy argues that as an ice sheet advance begins (for reasons unconnected with the carbon dioxide "budget") there is increased erosion both by the glaciers and by water running off the continents into the falling seas. As sea level falls (because water is trapped in the ice sheets) sediments now locked up in river deltas would be eroded. So, with more organic material and more fixed nitrogen reaching the seas, there

would be a marine population explosion, leading to a removal of carbon dioxide from the air and, by a positive feedback, encouraging the Ice Age to develop.

As the Ice Age stabilised, the runoff of nitrogen-rich sediments would decline, the marine organisms would fare less well, and carbon dioxide could again build up in the atmosphere, playing a part in ending the cooling phase (*Nature*, vol 302, p 328). But this would not happen for tens of thousands of years, because of the slowness of the upwelling currents.

Intriguingly, this slow pulse beat of climate could resolve a puzzle concerning the favoured "Milankovitch model" of Ice Ages. This model "explains" climatic changes on a timescale of tens of thousands of years in terms of changes in the Earth's orbit and inclination to the Sun. But the climate cycles are too strong to be explained as the direct effect of the astronomical changes alone. The discovery of a feedback mechanism which enhances the pulse of these cycles therefore fits in very well with the developing consensus on the cause of Ice Ages. □

TECHNOLOGY

New frequencies: same radio shows

BRITAIN'S home secretary, William Whitelaw, has revealed plans to open up more of the VHF radio band for broadcasting. But the new channels are unlikely to carry anything other than the bland fare that the BBC and local radio stations now offer.

Whitelaw has told parliament that Britain's proposals to a European conference next year on allocating the VHF band are likely to include two new national radio networks. There will also be more frequencies for the BBC and commercial local radio, and for improvements to the coverage of existing services.

BBC's Radio 1 will get one of the new national networks. For the other, the home secretary will favour the Independent Broadcasting Authority's submission for an independent national radio—"provided that satisfactory financing arrangements can be developed".

Finance could be a problem. Commercial local radio stations rely on national advertising campaigns for about half of their revenue, and on local campaigns for the other half. Some of the smaller stations already find it difficult to make ends meet—and the arrival of a national commercial channel, which would take most of the country-wide advertising, could put them out of business. So far, no one has put forward any specific plans for the new network, although a national news and information service on the lines of London's LBC has been mooted.

The BBC would prefer to use this fifth network for schools, the Open University, and for further education programmes. At the moment these displace the BBC's Radio 3 and Radio 4 from their VHF transmitters. But the corporation is "delighted" that the government has recognised its claim for an extra VHF network for Radio 1, which since 1967 has largely been confined to the medium wave band.

But the home secretary's statement gives no hint of the continuing dispute between broadcasters and the Home Office over the changes to allocations in the VHF band. In October and November 1984, delegates from all European countries will meet under the auspices of the International Telecommunications Union to plan VHF Band II. This band was expanded by the World Administrative Radio Conference in 1979 to extend from 88 to 108 MHz—previously it had stopped at 100 MHz.

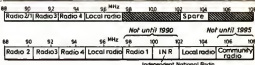
Broadcasters are anxious to get into the new frequencies as soon as possible. But in Britain, the Home Office is occupying a substantial part of this band, from 97.6 to 102.1 MHz for radios belonging to the police and emergency services.

In 1979, the Home Office persuaded the radio conference to allow it to continue operating in these frequencies until the end of 1989. It refuses to move out of them any sooner. "The more compressed the time-scale, the more expensive the process will be," a spokesman said. "The earliest new sets can be ready will be 1985, and we are planning to release the spectrum, about 1 MHz per year, starting in 1986."

But broadcasters are reluctant to wait. One local radio contractor said it seemed unreasonable that the Home Office should

be deciding between two competing claims on the spectrum when it was responsible for running one of them.

Another problem that the Home Office faces is the 3 per cent of listeners who cannot get good reception from the



Today's allocations (top band) and what the Home Office wants. The shaded areas are for non-broadcast allocations

networks as they stand at the moment. The BBC has always maintained that it needs more spectrum for each service to be able to provide more relay stations in remote areas. Its own frequency plan, which it issued last year, seeks chunks of the spectrum 2.8 MHz wide, instead of the 2.2 MHz sections it uses at the moment.

But if the world radio community accepts the plans outlined by the home secretary, the BBC's assignments will stay the same width.

One objection to the BBC's plan is that it would occupy the whole band from 88 to 108 MHz, leaving no room for new developments such as "community radio". The idea of community radio is for organisations outside the BBC and IBA to run stations. Among organisations that would like to see a more liberal approach are student broadcasters and hospital radio stations.

There are also groups that would like to set up specialist or local services which cater for interests neglected by present stations. Illegal pirate stations, operating on locally-free channels and low-power transmitters already fill part of this gap. The authorities are reasonably lenient—provided the pirates stick to uncontroversial material, and transmit only on Sundays.

The home secretary has said that the development of community radio raises difficult problems for broadcasting policy and that "... it would not be right to take matters further at present". He said that the government would consider developing community radio only when it knows the outcome of the 1984 conference.

Quantum leap in microscopy

THIS SHADY object is not the latest in orthopaedic mattresses, but a model of the surface of a piece of silicon. The model is the first three-dimensional



picture of atoms, each bump represents an atom, and was produced by IBM using a technique called scanning tunnel microscopy (STM).

Each bump is as little as six angstroms or, six 10-billionths of a metre from its neighbour, and was snapped by passing an electric current through the silicon, across a vacuum and up into the tip of an electrode moving across the surface. Repeated scans

of the surface produced this contour map of the silicon.

STM hinges on quantum theory, which suggests that electrons are given off in clouds from solids and will tunnel through a vacuum to other nearby conductors. The further away the other conductor is the fewer electrons will get through, so enabling scientists to map the surface of the first solid.

In IBM's method, the electrode tip moves up and down in a bid to pick up a constant current. These movements are recorded to produce the model.

IBM is using STM to study the surface of silicon, gold and thin layers of oxides in an attempt to learn more about the way it affects their electrical properties. The work could help to improve the performance of chips. Paradoxically, the only way to achieve "very large-scale integrations" or a true "computer on a chip" will be to make components an order of magnitude smaller than today's chips.

Europe calls the tune on computer graphics

A RIPPLE of raised eyebrows is running across faces in the European computer-graphics industry. For probably the first time in computer history, the US is to drop one of its standards, in favour of the International Standards Organisation's (ISO) Graphic Kernel System (GKS). But there may be problems getting individual companies to follow suit.

The organisation published a draft standard on computer graphics at the end of March. The British Standards Institution will probably adopt it virtually word for word, as will the German DIN (not surprising—the Germans did the original work). GKS is billed as the "first international computer-graphics standard". However, sales and industry standards are not always compatible in the computer world—and the Americans may be reluctant to fall into line.

"This is probably the first time that the Americans have adopted a European standard," says Dave Garnett of the Cambridge software firm CIS. "I'm slightly worried about people who adopt a standard things that haven't been implemented. One man's standard may be another's nightmare."

American manufacturers share this skepticism. "It will be a long time before there's any international graphics standard," says Dave Robertson, head of the US company Computervision's British operation. "I honestly don't know why GKS has been



Computer doodlers need standards

written. GKS probably won't find much joy from the suppliers with 90 per cent of their sales in the states. My guess is that GKS won't be taken up."

The market for computer graphics will be worth \$8 billion by 1986, twice its 1982 value, according to the Pacific Technology Centre of California. Manufacturers of

computer-aided design systems are jockeying aggressively to take advantage of this potential goldmine.

Peter Jones, of the ISO in Geneva, said: "The US is crying out for copies of the draft standard. It is a true, international standard: its importance to the industry is worth billions of dollars in the US. GKS is an enormous work of 280 pages that describes a set of functions for computer graphics programming." Sigma Electronic Systems of Sussex has already introduced a series of terminals that conform to GKS.

Dave Rosenthal of Edinburgh University chaired the BSI committee that recommended GKS be adopted as a British Standard. He accuses the Americans of being xenophobic: "It's very difficult for the Americans because it's most unusual for them to adopt a standard not written by the American National Standards Institute (ANSI)."

"There are many people in computer graphics in the US who don't believe that anyone outside the country knows anything about the subject at all."

The mighty IBM, which has probably set more industry standards than most other organisations put together, is not being drawn into the argument. "We're not ready to say anything about GKS yet. We're watching it and we're aware of it," a spokesman sniffed. □

China's rare earths stay in the ground

CHINA is having problems selling to the West what looked like becoming a big export earner—rare earth metals. The country is sitting on some of the world's most valuable supplies of these metals. According to one estimate, China's reserves amount to 100 million tonnes, as against 30 million tonnes in the rest of the world.

Unfortunately for China, it has found difficulties in tempting customers away from established suppliers. Trade in the metals—which have applications ranging from making TV sets to catalysts—is dominated by two companies, Rhône Poulenc of France and Molybdenum of the US.

The Propane Company, a London firm of traders, tried to break into the market by signing a deal with the Chinese to sell the metals to European customers. Now Propane is on the point of pulling out because of insufficient interest.

The term "rare earth" is a misnomer: the metals, which include yttrium, and members of the lanthanide series in the periodic table, are comparatively abundant. But they are present in the Earth's crust in low concentrations. The metals are found in ores in which several different rare earths are present.

China contains deposits of bastnaesite, a fluorocarbonate of lanthanum and cerium; monazite, a mixture of phosphates; and xenotime, which is mainly yttrium phosphate. Other big producers are Australia, Brazil and India, which supply monazite; and the United States, which has a huge deposit of bastnaesite in California.

One problem for the Chinese is in guaranteeing a consistent level of purity to

customers. China has about eight factories that refine the ore. These either produce a single metal (normally in the form of the oxide or chloride) or a mixture of the metals which customers may then separate. But different factories have produced a different quality of chemical. By contrast, Rhône Poulenc and Molybdenum have set great store on producing consistent levels of purity. China has also failed to adopt what would be the normal tactic of a Western organisation trying to challenge dominant suppliers. It has set its face against cutting prices.

Traditionally, the rare earths have been used as catalysts in the chemical industry and in flints for cigarette lighters. Yttrium and europium are in demand for use in phosphors for colour TVs. The rare earths



Where China's earths are rare

also play a part in the manufacture of coloured glasses, fluorescent lighting tubes, magnets, lasers and ceramics. The price of rare earths varies greatly: europium oxide costs about £1000 per kg. □

Cheap oil bleeds energy research

THE EEC's alternative energy projects are the latest victims of the world slump in oil prices. The Council of Ministers is split on the amount of cash aid that should go to projects, now at the demonstration stage, which would provide an alternative to imported oil.

The projects include work on exploiting geothermal sources, solar energy, wind and ocean energy and hydroelectric power.

The European Commission wants proper medium-term (5-year) funding for such demonstration projects. This would cost £300 million. But the ministers, especially now that Germany, the EEC's main paymaster is in the president's chair, are reluctant to put up more cash. As an

interim measure, the council decided on 14 March to give the nod to about £45 million to keep projects going for one year.

"It's a complex mix," one official said. "If oil prices go down, investment in alternative energy may be less productive in terms of pay-back time. It's a long-term problem, but politicians think in terms of months or even weeks."

The oil price drop has been a particular blow to the economics of solar energy. Last year, a passive solar collector on a house would have been expected to pay for itself in 12 to 15 years. This year, EEC officials calculate, the payback period would be 20 years. By that time the householder would need to buy a new collector. □

General Computer takes charge



Ike and Monty knew their stuff

COULD computers ever take the place of generals on the battlefield? At least one research team in the US is taking the idea seriously. "The main problem with fighting a modern war is that you have good generals and dumb generals," says Ed Taylor, of TRW Defense Systems in California. Taylor runs a government-funded research team which is trying to develop a computer that can make the right tactical decisions as consistently as the top 10 per cent of generals.

A feasibility study that TRW delivered to the Pentagon last month outlined the approach the project will take. The starting point is to observe generals' decisions at war games to identify what good commanders do that poor ones don't. The next stage will be to put that "judgemental ability" into a computer, teaching it to make intelligent guesses about events on the battlefield. The first automated system should be running by 1990.

One reason for TRW's optimism is that much of the groundwork has been done elsewhere. Last year a team at the University of Pittsburgh unveiled a medical artificial intelligence project called Internist-1, which could beat most doctors at diagnosing internal diseases.

Internist makes judgements by drawing

on numerical values attached to three variables—how often particular symptoms indicate a particular disease; how often patients with a particular disease show that symptom; and the general significance of a symptom (ie whether it is an unmistakable sign). The computer matches symptoms with diseases to draw up a hierarchy of hypotheses.

This quickly produces a short-list of competing diagnoses, which the computer concentrates on—just as a human doctor would. If the top solution has a much higher score than the next one down, the computer concludes that this is the correct diagnosis. If not, the computer refers a short list to the doctor.

The Pittsburgh team tested the machine on 43 complex diseases against clinicians and consultants at Massachusetts General Hospital. The computer made slightly fewer incorrect diagnoses than its human rivals, although it did less well in making firm diagnoses.

A new version of Internist, called Caduceus should be available for clinical use, probably to give second opinions, by the end of the decade. The TRW group is working on the same lines—but it will be a long time before GI Joe puts his faith in orders from General Computer. □

Video standardised at last

AFTER A YEAR of negotiations, 122 tape and electronics companies, 97 from Japan and 25 from the West, have agreed on a new standard for home video.

The discussions began in Tokyo in March 1982, after Sony, Matsushita, Sanyo and Hitachi had all separately demonstrated prototype "camcorders" (video cameras with built-in recorders). All four prototypes used special tapes, and were incompatible with each other—as well as with every video system already on the market. The manufacturers recognised that the camcorders would not catch on unless they adopted a common format, allowing video enthusiasts to record and play back tapes on different models of machine.

The standard the companies agreed is flexible in that it leaves room for technical developments before the camcorders go on sale, but is tight enough to ensure that all camcorders will eventually be compatible. The standard also leaves room for mains-powered home recorders, on the same format, which will offer enough playing time for enthusiasts to tape television

programmes or watch pre-recorded films.

Despite the success of the talks, they leave France out in the cold because Thomson proposed a different method of coding the colour information, and refused to compromise with everyone else.

The vital statistics of the standard are a tape 8 mm wide, coated with pure metal (instead of the conventional metal oxide) housed in a cassette measuring 9.5 × 6.25 × 1.5 centimetres. This is almost the same size as a conventional audio cassette.

The video writing speed (the rate at which the rotating video heads track across the tape) is 3.8 metres per second for countries such as the US and Japan which have 525-line pictures, and 3.1 m/s for Europe's 625 lines. This is much slower than any of the existing domestic systems, which use 12.5 mm tape, and is why the recorders need the high-quality metal-coated tape. Each cassette for Europe will run for 60 minutes; customers in the US and Japan will get 90 minutes' playing time. However companies hope to extend this to four hours. □

Hard sell time

UNIVERSITIES should gear their publicity machinery away from students and toward industry. In this way, companies that are largely ignorant about research in academe would realise the benefits of collaborating with the educational sector. That is the prescription of Stephen Bragg, a former vice chancellor of Brunel University.

Bragg says that universities urgently need to convince academics that popularising research is respectable. He made his comments at a meeting on research and development at the Royal Society in London last week. Bragg, who was once chief scientist at Rolls-Royce, works for the Science and Engineering Research Council, telling firms in the eastern part of Britain about what is happening in university research.

According to Bragg, universities should steer a middle path between the role of monk and worker-priest. They should neither remain aloof from what goes on in life, nor should they spend all their time solving industrial problems. □

Battery charge

BBATTERIES for calculators, watches and heart pacemakers could soon last ten years, if research at St Andrews University in Scotland pays off. Britain's Science and Engineering Research Council has granted the university £15 250 for work on new battery systems.

The battery group, under Dr Colin Vincent, aims to develop a new range of materials to improve the reliability of batteries and to make new ones that are smaller and lighter than today's batteries.

Vincent said that a few years ago watch batteries had to be renewed every year. They now last five to seven years, and the 10-year battery is on the way. The St Andrews team is also looking at rechargeable batteries, as well as at "high-power throwaways". His research will be carried out in collaboration with industry in Europe and the US. The University of Rome and the Polytechnic of Milan will also take part. □

Winter panes

A NEW type of double-glazing, based on an idea from the Massachusetts Institute of Technology, is about to go on sale in Britain. The "Heat Mirror", will cut the heat loss through a window to one-quarter the loss through a single pane of glass.

Conventional double-glazing cuts heat loss by conduction, but cannot prevent loss by radiation. The Massachusetts scientists developed a thin plastic film, coated on one side with a sandwich of indium oxide between silver. Because the sandwich is only a few angstroms thick it transmits visible light—but it reflects longer-wavelength heat radiation. So heat in the room does not escape.

Loughborough University has built a test rig to compare the new glazing, which Alpine is making. The testers found that a Heat Mirror has a "heat loss factor" of 1.4 compared with a single window's factor of five. □

FORUM

Model shops for beginners

Jack Trevor Story puts model shops to the acid test

ALTHOUGH the world around us here in Milton Keynes at any rate has become, forgive the word, technological, nobody knows damn all about science. Don't be fooled if you are on my side of the generation gap. Across there, with the computer addicts and dirty video users, the boys building their own bombs, is nothing. An abyss, a dark age. The Open University freaks have taken so many short cuts that they are rudderless ships on that same deep ocean which you, most probably, crossed with nothing more than a paddle or ragged bit of sail under a stiff breeze and with a lively brain.

I'm sure you feel better already.

I'll give you another paragraph. It makes it easier to read. So anyway, I said to Jonathan Sale on *Punch*, how about doing Model Shops? I write *ShopTalk* for *Punch*. Jonathan said, "We've done them—you mean Dinky Toys and so on?"

The engineers among you who cut your teeth—using a diamond-tipped turning tool if working on something hard—in the firm's model shop, will rage and roar and split asunder with bellows at Jonathan's mistake. Be kind, however. Worse for me. I am and always will be a pH engineer. For ten years, following ten years apprenticeship, I worked on pH measurement, recording and control, electronically of course, in field, laboratory and factory, mill and refinery. Nobody knows pH. Nobody knows what I am.

"I thought pH was something you put on your hair!" Margaret Thatcher said, during one of my imaginary lectures to her. And she has a science degree. A BSc, perhaps or a PhD even. BA, MA, you name it—PM? But no pH. You can't get anything with a little letter first except pH. That is a scale of acidity and alkalinity based on 14 times the logarithm of the ratio of dissociated hydrogen ions in an aqueous solution measured in grams per litre.

This confident recital after 30 years away from pH always quiets the listener who will try to change the subject. He'll mention, if with a little learning, crude and neanderthal methods of turning red to green, litmus paper, colorimeters, titrations. Have none of it. Pull out your glass electrode and wave it in his face.

W. B. Bartley, my chief engineer at Marconi Instruments, and my own personal friend and boss—I cleaned his car—once said: "An engineer, Story, can do everything!" This would not have been so impressive if he had not previously said—for I was also with him at Murphy Radio before the war—"Some people have to work, but some can run barefoot across the grass!" I think it was the other way round. He was telling me to get back to pH

and stop writing fiction. People will always need pH, was one of his predictions. Now they're putting it on their hair.

That is a semi-comical line of course. Try to pick out the sense of what I am saying. For instance, it so happens that my grand-

second-rate, cheapo. The English working class were all fascist (and are again).

My mother used to say, "Don't you go talking to any gippies, niggers, tramps or jewboys." She was Baptist, we were the little elite. When I wrote my novel *Hitler Needs You* (we were the people Hitler needed most) it was picked up for review by Elizabeth Thomas, literary editor of *Tribune*, as being the one book for her which showed what England was really like in the thirties. I expect that's why it hasn't been re-published.

"Hitler is doing wonderful things," the old English craftsmen used to say, sharing their wisdom with me and Tolliday my mate. Oh, they were my daily joy. Dirty Dick, Harry, Bert, Prickwillow, working on the green baize under the bench lights, the elastic band round the

grey heads holding the jeweller's eyeglass or checking their tolerances with the white-coated draughtsmen, or rouging the last tenth of a thou from a newly-turned and bored brass centimetric attenuator.

I once saw Bert cry tears when he had roughed a gnat's cock too much off. I once saw Tishler cry tears when Hitler marched into Vienna. Tishler made the first microphone for Dame Clara Butt at the Landessender Vienna studios. "Listen! You know what? I made it out of a fucking cocoa tin!" Our Mr Phillips helped John Logie Baird rescue the gear, carrying it out through the flames the night Crystal Palace burnt down.

Several years' night school and a year day-release on servo maths at North London Poly underpinned my Model Shop beginnings. But show business was already taking my mind. I had got first prize for guitar at the *Melody Maker* contest and soon I was selling stories and now I find my principal interest is still pH.

Well, I haven't seen it in a little box yet. At the garage there is MICRO CHIP WHEEL BALANCING and at the bookshop MICRO FICHE book information.

"You've got nine titles in print," said Ben. She is the pretty lady in charge of Oakleaf. I thought that was marvellous—not the titles but getting it all listed in five seconds on a screen.

Sometimes I'm not very impressed by the scene. An awful lot of research seems to have gone into nothing. That pulse generator for switching little channels we developed for computerising remote control of shell velocity measurements on Pendine Sands.

On second thoughts—that's progress.

"I like your hair," I told Ben.

This is my new approach to long-winded chat-ups about my pH past. □



son, Henry now works in the Marconi laboratory. He knows nothing. Henry knows nothing! He's a sensible lad and would be the first to admit it. He knows how to work all the instruments and what results to expect and how to talk the jargon but that's not it.

"Do you know anything about wave analysers?"

"Yes, grandad."

"Then how is it you keep your tone control at the bottom, cutting off all your natural harmonics?"

"That's mum," he said, a little too quickly.

Henry has not worked in the Model Shop. The Model Shop is the heart of engineering. Not Dinky Toys. I was lucky enough to learn my practical engineering in three of this country's good Model Shops, Pye, Murphy, Marconi. Making prototypes and one-offs, you have to make everything yourself, by hand. Tools, jigs, moulds, cut and beat your own chassis in soft aluminium or steel, make your own pin and fly cutters, screw-cut inside and out, engrave, wind coils (chokes, transformers), know forging, hardening, tempering, the use of precision instruments.

"Wash your hands first," Ernie used to say—or Simpson or Blondie Taylor. A Model Shop foreman was your first link with the universe; a strange and mystic blend of work and nous. They could do things by thumb and come out within a thou. My Model Shop foreman played string bass, did all-in-wrestling in Chicago, led donkeys over the mountains of Columbia. Dinky Toys?

And you had to sign a chit to use things like the height gauge, the big micrometers, calipers. Everything was German except the shadowgraph. And that was American. In 1937 anything British was suspect.

Jack Trevor Story is an author of numerous books and once earned a living as an engineer. He first broke into print in the pages of *Instrumentation and Electronics*, and now lives in Milton Keynes.

... many Westerners are indignant when seeing an Indian mahout raise high his ankus ... and bring it down on the head of his inattentive elephant



May Evans

How should we treat animals?

David Challinor on man's changing attitudes to his global cohabitants

IN THE JUDEO-CHRISTIAN tradition, human beings, closest to God, believed that they had dominion over all his other creatures, which He created for human benefit. There was thus little organised public concern over the ethical treatment of animals until the formation of the Societies for the Prevention of Cruelty to Animals, in Britain in 1822 and the United States in 1866.

The founding of these organisations gave real impetus to a movement directed towards improving the lot of domestic animals. Watering troughs for horses were installed throughout cities and standards were gradually set for livery stables, slaughter houses and other facilities handling animals. Such regulations did not in themselves stop inhumane treatment, but they heralded a movement that has grown steadily on each side of the North Atlantic, both in numbers of its adherents and its influence on legislation.

Today in Western Europe and North America, overt cruelty to domestic animals is rare—so rare that flagrant violation of commonly accepted treatment is newsworthy and universally condemned. What we perceive, however, as cruel treatment is not universally shared and for many non-Westerners, our behaviour seems strangely contradictory. For example, many Westerners are indignant when seeing an Indian mahout raise high his ankus (an iron rod with a hook at one end) and bring it down smartly on the head of his inattentive elephant. Such action, however, is hardly cruel for the porous structure of the dome of an elephant's skull easily absorbs the blow. Conversely, Orientals and Africans rarely mutilate their pets for cosmetic purposes, but the trimming of puppies ears of certain breeds to make them stand erect or the breaking and subsequent resetting of the tails of American saddle-bred horses, or was until very recently, a common practice in American dog and horse-show circles.

Given such inconsistencies, how are we to treat animals? The only answer in truth

is "it all depends". A first criterion might be that the treatment at least has to be considered acceptable to the majority of the local culture. Such a standard is not very helpful, so we therefore can suggest certain guidelines.

Generally the larger the animal, the greater the concern with its ill-treatment. Thus the abuse of a horse will generate more adverse reaction than similar abuse of a rat or mouse, even though whipping a tired horse is scarcely comparable in "cruelty" with using chemically treated bait on rodents to induce lethal internal haemorrhaging. Exceptions to the criterion of size are those large animals we consider "bad", such as sharks, large venomous snakes, crocodiles, and among mammals (until very recently) killer whales and grizzly bears. Their abuse was tolerated if not actually encouraged by the general public.

An extreme example of Western attitude towards animals is the so-called blood sports, most of which have now died out. These activities supported high-stakes gambling, for example, on the outcome of fights between selectively bred bull terriers. These organised dog fights are still practised surreptitiously in the United States, but are now mercifully illegal throughout the Western World.

Bull and bear baiting have gone, but we are left with remnants of former use in such breeds as bulldogs, whose exaggerated lower jaws were developed through selective breeding, to hang onto the muzzles of bulls. Cock fights, however, are still legal in six of the United States, perhaps because we still eat chicken regularly, but no longer dogs. Birds are much lower on the evolutionary scale, which is another criterion in determining what we consider cruelty to animals.

Hooking a fish and letting it suffocate in a creel is seemingly acceptable to all fishermen and many other people. As we

descend the evolutionary ladder, our behaviour becomes, increasingly extreme. We routinely boil crabs and lobsters alive, and consider eating live clams and oysters a gastronomic treat!

Our behaviour therefore may seem inconsistent and irrational, but should be considered in the light of our sharing with all living organisms a finite planet. Conscious or not we compete with them, as well as among ourselves, to survive. Those humans who are surviving most successfully, now spend time considering the welfare of other creatures.

Although, historically, man has modified animal behaviour, and its physical characteristics for his own benefit, we have only now begun to weigh the ethical consequences of our activities with animals. A relatively new approach has emerged—that of animal "rights". Advocates of such rights raise complicated legal questions and seem to be extending a legal status to non-humans. The law is still unclear on the legal rights of human fertilised ova (zygotes) and even fetuses, so that it seems unlikely that animals will have legal rights for many years.

Whatever the legal outcome might be, animal activists have been successful in stopping or limiting the exploitation of wild populations. The harvest of young harp seals, for example, will probably soon cease completely; and although a total moratorium on whaling has not yet been achieved, it at least now seems in sight. A new target for action is laboratory animals and bills are pending in the US Congress to eliminate or minimise duplication of experiments involving such creatures.

Although there have been well publicised incidents of alleged poor husbandry of laboratory animals, most well-run organisations have too large an investment in their stock to afford mishandling them, especially primates, whose importation is



Art Brown
"... exaggerated lower jaws were developed through selective breeding to hang on to the lower jaws of bulls."

now severely restricted. Nonetheless a group entitled Mobilization for Animals intends to picket primate research facilities throughout the US at the end of April.

There will always be conflict in people's perception of proper animal care, but it is easier to set standards for handling domesticated animals than for exploiting wild ones. Domestication or controlled breeding of hitherto wild animals for their products has been commercially successful: witness such ventures as fur ranches for silver fox, mink, and chinchilla. An unusual and profitable business in Thailand is exporting 2000 skins annually of a hybrid crocodile (*Crocodylus porosus* X *C. palustris*).

If we continue the trend towards domes-

Dr David Challinor is the assistant secretary for science at the Smithsonian Institution, Washington DC.

tication and away from harvesting wild animals we will have a new problem, that of controlling rapid expansion of those wild animals freed from commercial harvesting or hunting. Raccoons no longer trapped for their fur, have invaded suburbia around Washington and a few have recently been found to be rabid. Elephant seals have started hauling out on mainland beaches in southern California because their offshore island breeding grounds have become too crowded. Very soon we will have to find a politically and ethically acceptable method of controlling those competitors of humans and their pets.

Domestication of new animals for their products will probably expand to meet

the demands no longer met from wild stock. Such expansion should lead to improvement of animal treatment through better controls. Where do we end? Animals are not human, therefore it seems inappropriate for them to have legal rights. As fellow creatures on this planet, however, they deserve respect and considerate handling. Furthermore, the study of wild animals may lead to insights into our own behaviour and biology. The observations so obtained should at least be free from the human bias that attends the study of our own species. Live well with all creatures in an apt dictum for today, because we seem as humans to be getting out of balance with the rest of the world's occupants. □

Industry's audible boom

Robert Taylor has been listening out for the sounds of an economic recovery

THE BRITISH government is looking eagerly for signs of economic recovery but is may not have noticed that the quickest way of discerning increased industrial activity is not to look at it, but to listen. A high proportion of Britain's manufacturing output comes from factories near to houses. Many of these factories work at night; when manufacturing output was at the high levels of the late 1970s, many thousands of people went to sleep (or tried to) with the sound of local industries buzzing in their ears.

Between mid-1979 and the end of 1980, the output of Britain's manufacturing industry fell by some 12 per cent; and many parts of the country became quieter at night. The fact that production is now starting to pick up is changing the nation's sleeping habits once again.

In general, Britain's laws do not lay down limits to the noise that a factory makes outside its walls, although in some cases local councils have permitted factory developments only on the proviso that they do not exceed specific sound levels. And there are a few special areas called "Noise Abatement Zones" where local authorities keep statutory registers of permitted noise levels. But under current legislation most factories have merely to use the "best practicable means" to keep noise to a minimum. This extremely loose phrase means that trying to quieten a noisy factory can be a long, complicated and very tiresome business.

If a resident is bothered by a noisy plant he normally must persuade his local authority's environmental health department to take action which, if friendly persuasion fails, end up ultimately in the magistrates court. Here, the factory can plead that given problems of finance and technology, it is doing the best it can to reduce the noise.

The environmental health officer, for his or her part, will almost always rate the noise according to a standard formula. He compares the sound with background noise (that due to traffic for instance) which is present all the time. The comparison is relevant as people perceive noise not so much in terms of its absolute level but rather as the relationship of the noise to what exists normally. People often say that

a certain noise gets louder at night, even though its measured level does not alter; this is because, at night, the level of the background noise is generally lower than it is during the day.

During the recession, people near once noisy factories started to appreciate the quiet. But problems occur when night-shifts restart. Complaints are likely to rise, even though the sound levels may be lower than they were during the relative "boom" days before the recession.

The upshot of all this is more problems



for hard-stretched environmental departments—and more court cases that are decided unsatisfactorily, more on the whims of magistrates rather than on concise technical criteria.

The new surge of complaints could strengthen the argument that Britain needs to frame more acceptable noise legislation. Most other Western countries take a more definitive approach to noise legislation so that in, for example, a suburban residential area the noise level from industrial and commercial premises shall not exceed say, 50 decibels by day and 45 decibels by night. This is the kind of stipulation that could make the job of deciding on "satisfactory" levels of noise in what is left of industrial Britain a lot easier. □

Robert Taylor is a noise consultant.

Disease-of-the-month politics

Dan Greenberg reports from Washington on arthritis and total name replacement

THE SO-CALLED disease-of-the-month club is currently mustering legislative support for an objective that it almost reached in the last session of congress: creation of a separate headquarters for arthritis research at the National Institutes of Health (NIH).

In other lands, such matters of biomedical organisation would be settled in chambers by anonymous public servants. But health research is serious political business in the United States, and with the patient population for arthritis estimated at 36 million, the basic material exists for drumming up intense public interest. Such was done last year when the Arthritis Foundation, a non-profit organisation that focuses on that disease, persuaded both the House and Senate that arthritis research was being neglected in NIH's National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases. In the foundation's view, arthritis should be taken out of that conglomerate and set up in a new and separate institute, which would bring the total number of institutes at NIH to 12.

The rationale for the move, which was ardently opposed by the NIH's management, was that arthritis was a victim of budgetary neglect—getting less than 70 million clearly identifiable dollars out of the NIH's \$4000 million mission for the year. The counter, from James Wyngaarden, NIH's director, and his immediate predecessor, Donald Fredrickson, was that contemporary biomedical research is a seamless entity at the sub-cellular level, and that labels on the laboratory door are increasingly meaningless. Furthermore, they argued—with little effect—NIH was hard pressed for cash, and the costs of setting up a new institute would almost surely come out of the research budget.

With ample historical evidence on their side, the expansionists replied that visibility was a tested means of swelling research budgets. The best case in point, of course, is the quadrupling of funds at the National Cancer Institute following Richard Nixon's declaration of the "war on cancer".

In any event, the proposal came close to being passed, and failed only because of last year's legislative jam-up. Helping it along were the customary health-lobbying tactics, such as having Senator Barry Goldwater, still recuperating from a double hip-joint replacement, hobble into a hearing room on crutches to testify on behalf of the proposed institute.

While the NIH establishment insists that the present array of 11 institutes nicely spans the life sciences, the history of the great biomedical-research enterprise is filled with politically inspired name changes that almost always were followed by bigger budgets.

For example, in 1950, the National Institute of Arthritis and Metabolic Diseases was founded. In 1972, it was

expanded and renamed the National Institute of Arthritis, Metabolism, and Digestive Diseases. Ten years later, it became the National Institute of Arthritis, Diabetes, Digestive and Kidney Diseases. The disappearance of "Metabolism" is attributed by some skeptics to the absence of a lobby for that biological process. Whatever the reason, the annual budget for arthritis *et al* went from \$7 million to around \$400 million in 30 years.

Then there is the evolution of what started out in 1950 as the National Institute of Neurological Diseases and Blindness. In 1968, the last word in its title was dropped to make way for the National Eye Institute. But with the loss came a gain and the result was the National Institute of Neurological Diseases and Stroke. In 1975, it expanded into the National Institute of Neurological and Communicative Disorders and Stroke. Vast fiscal growth followed those expansions, too.

As for the pending proposal concerning arthritis. The House version calls for establishing a National Institute of Arthritis and Musculoskeletal Diseases. The Senate version, however, is in the expansionist spirit: it calls for establishing a National Institute of Arthritis, Musculoskeletal and Skin Diseases. □

ENIGMA

No. 208

Snooker doubles by Susan Denham

In a recent frame at a snooker match there were no penalty points and after each of the 15 reds was potted a colour was potted (each of the six colours following two or three of the reds). The surprising thing about the result was that the winner's total score was twice that of the loser, and yet they had both potted the same total number of balls.

What was the loser's total and how many reds, how many yellows, how many greens, how many browns, how many blues, how many pinks and how many blacks did he pot?

(In snooker the potting of a red is followed by the potting of one of the other colours, the red remaining down but the other colour returning to the table. After 15 such events the remaining six colours are potted in the order stated above, reds are worth 1 point and the rest 2-7 in the order stated above.)

A £5 book token will be awarded to the sender of the first correct solution opened on Thursday, 5 May. Please send entries to Enigma No 208, New Scientist, Commonwealth House, 1-19 New Oxford Street, London WC1A 1NG. The Editor's decision is final. The winner of Enigma No 205, *Doing it by halves* was M. Wickins of Studley, Warwickshire.

Answer to Enigma 205

Doing it by halves

2222

6	3	4	9
7	8	5	0
6	1	2	7
2	3	4	9

The complete square

Passing the mink in the Shetlands

Tam Dalyell MP sees wildlife threatened by government inaction

IN RECENT weeks, this column has focused on Earth-shattering issues, such as the international arms trade, and the West's relations with the Third World. So let me turn to an issue, less Earth-shattering, but no less vexatious—the keeping of mink in Shetland.

I have been to Shetland in various capacities. First, as a director of studies on the School Ship Dunera, uplifting 135 Shetland children from Lerwick, to take them, in 1962, to Bergen, Oslo, Copenhagen, Hamburg and Amsterdam. In their gorgeous knitted sweaters, these youngsters had far more in common with their Scandinavian cousins than with their

Council made it clear that it had no intention of grasping the nettle itself, and taking any decision. This was a matter of mini-politics: the Shetland Branch of the NFU opposed an article for imposition, the crofters' union supported the suggestion. However, in the tiny political pond of Shetland, important issues can be affected by seemingly trivial considerations. Because the local representative of Burra and Trondra was not at the February meeting, the matter was deferred until March, when again the councillor for the area failed to attend, resulting in yet another deferral. The sense of comic opera or mini-tragedy was reinforced by the fact that at



Bruce Coleman

Feral mink have serious implications for wildlife

fellow countrymen on the school ship from West Ham—though the two British groups got on fine, expressing mutual wonder at one another's behaviour. The Shetlanders were the only children I have ever known who had only to be asked once to perform in public, without even token resistance they took to their fiddles and played. Later, as a Member of Parliament, I have been to see archaeological sites—Clickimin Broch is one of the most remarkable in Britain—to talk to multinational oil companies at Sullom Voe, and to campaign against the Scotland and Wales Bills of 1978-79, successfully, as it turned out. I say all this because no people on the face of the planet could be more attached to their island than the oft-far-travelled Shetlanders.

Now, in November 1982, the Shetland Islands Council agreed to grant aid a proposed mink farm on the island of Trondra. At this point, the Shetland Bird Club, the Nature Conservancy Council, and the Royal Society for the Protection of Birds requested the Secretary of State for Scotland to issue an Article 4 direction over the keeping of mink in Shetland. An order under Article 4 of the Town and Country Planning (General Development) (Scotland) Order of 1981, would in effect require all proposals for mink farming developments in Shetland to apply for planning permission.

Then the Scottish Office asked the Shetlands Islands Council for its views. By 12 votes to 2, the council's General Services Committee voted not to oppose the imposition of Article 4 by the Scottish Secretary. However, the Shetland Islands

the March meeting the Shetland Islands Council received a letter from the Scottish Office, indicating that as ministers would not be able to deal with the issue "for quite some considerable time", could not the Shetland Islands Council sort out the matter?

Back and forth has the buck passed. Many months have elapsed. No resolution of the matter looks in sight. Yet, during all this period, there has been nothing to prevent the applicant from pressing ahead with all speed on the actual construction of the mink farm on Trondra. And this is precisely what he has done, to present everyone else with a *fait accompli*.

A storm in a northernmost tea-cup? No, it's more serious in my view. The reason why I have detained readers of *New Scientist* with such minutiae is that the "Mink on Shetland" presents us with a case study of the way in which decisions affecting the wildlife of Britain are being left to the ephemeral whims of local personages. Trondra should sound alarm bells for the vast membership of the RSPB and for the Nature Conservancy Council. The pros and cons of mink keeping on island groups such as Orkney and Shetland were fully presented at a public enquiry held over a similar case on Westray in Orkney in 1978. That inquiry turned down the application on the grounds that the mink farmers could not guarantee that mink would not escape. If mink escaped they could readily establish themselves in the wild, with serious implications for the indigenous wildlife: particularly at risk would be large colonies of ground-nesting seabirds, such as terns, puffins and black guillemots. Shetland is one of the few areas in Britain which remains free of feral mink. Mink keeping in the past did lead to the temporary establishment of wild mink—the escape occurred at Wormdale, in Shetland when the winds blew a hut through the farmer's perimeter fence, liberating a number of unmated female mink.

The basic trouble is that this is another

example of approaching a situation whereby government ministers, for one reason or another, do not appear enthusiastic about using their powers. This is coupled with a situation where the local authority, having in the first place backed a particular scheme such as milk-farm construction on Trondra, is reluctant to make a U-turn in its attitude for fear of incurring compensation costs. Sheltering under the banner, or figleaf, of "agricultural development" is not a proper stance for

those who make decisions or principle, by action or equally by inaction, on major conservation issues, involving important principle.

The junior minister at the Scottish Office, Allan Stewart, tells me that his role in matters such as milk in Shetland is no more than that of "essentially of a confirming authority". If this philosophy prevails, we might as well wave "goodbye" to any idea of a wildlife strategy in Britain. The role of government has to be more positive. □

Never cross a potential reviewer

Milton Love on the art of taking criticism

I HAVE always suffered from an easily bruised ego (the result of either too early, too late, or perhaps no toilet training). The slightest criticism generates an overwhelming impulse to impale myself on my microscope eyepieces. As criticism is the backbone of the scientific method, this accounts for the indentations permanently sunk into my chest.

Any manuscript submitted to a scientific journal, or any proposal sent to a granting institution, is subject to close scrutiny. In theory, these criticisms are designed to help researchers to improve their work by pointing out (for instance) poor techniques, illogical conclusions or misanalysed data. Although these ideals are often met, there seems to be many instances where comments are wide of the mark.

For example, here is a cunning bit of advice one researcher received from an anonymous journal reviewer: "This manuscript is terrible. It breaks every rule of elegance in ecological thought, statistical analysis and presentation. I cannot imagine how it could be revised so as to be suitable for publication anywhere. Why isn't... an author? I realise that group endeavours can lead to strange proprietary claims to data sets, but I wonder if... didn't refuse to be associated with this gibberish."

Interesting marginalia, no doubt, but does it further the cause of science? On reading such statements, would Ptolemy have seen the error of his ways, instantly recanted and toddled off to join the Copernican revolution?

Or what about this constructive comment penned by a biologist reviewing a grant proposal. "Even in Los Angeles, a gifted, experienced posidoc or technician... can be hired for under \$17 000/year. I think that the \$22 000 requested for... is patently unjustifiable."

One might believe that such matters were outside the reviewer's purview. But

Down-to-Earth satellite

"The chain of events started with two satellites—Meteosat II and NOAA 6 (pronounced 'Noah 6'). Meteosat is in geostationary orbit 22,000 ft above the Greenwich Meridian and NOAA 6 is a polar orbiter going around the Earth once every 90 minutes."

Computer Talk, March 28/April 4. Okay, so people in glass houses... but a satellite in an envelope four-miles, or thereabouts, high?

no, not only is he or she a competent scientist, but also something of a labcoat-frocked economist.

Why are we seeing this lack of grace? Is it yet another symptom of the general decay of Western civilisation so well exemplified by widespread social disorder, the decline of moral standards and the onslaught of printed toilet tissue? One possibility is that, by being asked to review a paper, one's professional standing is on the line. Because everyone realises that all research is flawed, not attaining a quota of *bon mots* might be construed as a sign of inexperience or even worse, weakness. Then, too, there are those who believe that catcalls truly pass for constructive criticism. I have had a reference to bovine excrement splashed in red ink across an entire manuscript page. No explanation or suggestions accompanied this rather singular statement. One must stand in awe of the scientist so Promethean that a single obscenity is all that is needed to clarify and educate.

For those who have taken refuge in full-blown paranoia, there is another, more sinister, possibility. In these days of dwindling research funds and increased competition, what better way of disposing of rivals than by characterising papers or proposals as so much chaff? If your review does not stop them, at least your rapier has sown confusion and dismay. Hence, reviewing is felt by some to be very much a test of wills. Perish that one might be polite or circumspect—such is the mark of the aesthete.

In this environment, the true scientist's heart naturally turns to thoughts of revenge. Unfortunately the anonymity of the process limits the opportunity to put out contracts on those most worthy of such largesse. Alas, even knowing the name of one's villifier may not be sufficient. Indeed, the need to maintain the facade of politeness is often paramount. This was most forcefully brought to my attention during the formative stages of a literature-search project conducted by an associate and

myself. We circulated a letter to various individuals in the field asking if they had any unpublished records we might need. Among the generally positive replies was a negative one, stating that these lists always contained and perpetuated errors and that we would be better off accumulating a vast, unwieldy library of pertinent papers.

In seeking to allay our respondent's fears, we replied that we were aware of the problems and were trying to minimise them. In this regard we wondered if he had opinions about certain taxonomic questions, after which we listed several problems that were currently being debated by the scientific community. He replied, in part, "The questions and problems which you indicate are exactly of a nature about which I warned you. It is obvious that, if you cannot handle these problems, you are not qualified and therefore, should not be presenting such an enterprise as an independent project." He ended by stating, "I might also include a quote from Shakespeare: 'Fools rush in where angels fear to tread.'"

I was, to say the least, nonplussed. Extricating the eyepieces from the furrows in my chest, I stumbled over to my associate's office.

"You look upset," he said.

"Why do you say that?"

"You're sucking on a lit bunsen burner."

The more stable member of the partnership listened impassively to my reading of the letter. He looked reflective and said, "Shakespeare didn't say that. Pope did."

Oh, we've got him now," I cackled, capering with glee. "We'll write him stating, 'Since you obviously know nothing about English literature, we expect you never to quote from it again.'"

"We can't do that," my associate said.

"Quite right. Well, how about 'Dear sir, you have made an error which in the context of your foetid letter, was

delightfully egregious.'"

"No."

"Might I just put my ego in formalin and send it to him?"

"We can't do anything. What if he is asked to review a paper of ours someday?" There it is, of course. Woe to anyone who crosses a potential reviewer. We must grit our teeth and take what is handed out.

However, I have installed felt pads on the eyepieces of my microscope. □

Quantum stop?

Science fiction becoming science fact as an offshoot in the electronics and computer industries. And recent work at Sussex University could be a prelude to another episode of pop that is the form of electronic circuits with swirling speeds of ions. The technique is to use superconductivity to create metal rings that act as a night, quantum-like particle.

U.S. News & World Report, April 18, 1983, p. 50. The technique is to use superconductivity to create metal rings that act as a night, quantum-like particle.



Shaft of light for Britain's tin mines

Britain's only major industry in digging up metals is based in Cornwall. There a workforce of 1500 saves the country some £30 million per year in imports by mining tin. Over the past couple of millennia, the industry has had its fair share of problems, but modern processing techniques (not to mention an increased tin price) promise to extend its life

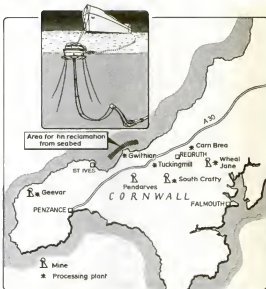
Peter Marsh

A SANDY beach in Cornwall may seem an unlikely place for a modern metals-processing factory. But within the next few weeks labourers will start digging the foundations for a plant at Gwithian, on Cornwall's northern shore, which will produce about 500 tonnes of tin per year.

Tin production in Cornwall is nothing new. The Phoenicians discovered the metal there some two and a half millennia ago. They called the islands of Great Britain 'the Cassiterides'—from which was derived the name for tin oxide, cassiterite. In the heyday of Cornwall's tin industry last century, some 400 mines were active, employing 30 000 people.

What is different about the Gwithian plant is that it is part of a reclamation operation. A dredge chugging around the Cornish coastline will suck up, with equipment resembling a giant vacuum cleaner, the mining waste that previous generations of tin miners have allowed to flow out to sea in streams and rivers. The waste contains tin oxide, in proportions too minute for last century's miners to recover. But with modern processing equipment, Marine Mining, the company behind the project, thinks it will obtain 1 kg of pure tin for every 2 tonnes of waste dredged from the sea bed.

The company will obtain the material from an area extending from St Ives Bay in the west to Cligga Head near Perranporth. This stretch of coastline contains the outlets of no fewer than seven rivers. But there are no suitable harbours for landing the dredged spoil. So Marine Mining's vessel will bring the waste to a floating buoy 700 m from the shore at Gwithian. From here a pipeline will transport it to the plant, which is due to start up in 1985 and continue until the material is exhausted 20 years later.



A plant to process tin ore will start up at Gwithian. It will obtain material from the sea bed via a pipeline (top)

Over the past couple of years Marine Mining has spent £1.3 million surveying the sea bed to discover the most concentrated deposits of the waste, which generally forms a layer about 1 metre thick. The company has already beached about 150 000 tonnes of tin-bearing sand, processing it in a pilot plant to see if the technique will work. The new factory will bring the total investment to £3.3 million, provided by the project's backers, a trio of wealthy Americans.

The reclamation venture provides just one example of the resourcefulness which engineers have to display to succeed in tin mining in Cornwall. By comparison with other parts of

At Geevor mine near Lands End (far right) tin-bearing rock won from underground (right) is sorted and then crushed (below) to produce relatively fine particles. Then follows extraction through "shaking tables" (bottom). A slurry of fine particles passes over the tables which vibrate gently, separating the heavier granules of tin oxide from other rock



the world, the deposits are present in very low concentrations.

In total, Cornwall has produced some 2 million tonnes of tin, according to estimates. Most of this was brought to the surface last century, when mining of other metals was also important. There were mines for copper, lead, cobalt, nickel, antimony, manganese and uranium.

Over the centuries Cornwall's tin output has totalled about 10 times the annual quantity the world produces now. Malaysia, Thailand, Indonesia and Bolivia account for 70 per cent of world output. Nowadays, Britain relies on imports for about half its consumption of tin. The four mines still operating in Cornwall produce about 4000 tonnes per year.

Cornwall still contains a lot of tin. The trouble is that the old mines consumed most of the deposits that were easiest to work, those close to the surface for instance. These mines were frequently tiny operations, perhaps run by families which might work an area only for a short time.

Only if the deposits turned out to be big would the "adventurers" ("directors" in today's parlance) in charge of the mine appoint a "captain" as overseer. He would be assisted by several "underground captains", experienced miners who acted as foremen, while "grass captains" supervised surface work. The homely nature of many of the old works is testified by their names—Wheal Ale and Cakes, Wheal Cupboard and Wheal Bread and Cheese. ("Wheal" is Cornish for "mine".)

Cornwall's mines owe their existence, first and foremost, to the molten granite which forced its way toward the surface some 250 million years ago. Later, as a result of other movements in the rocks, fissures opened up in the slowly solidifying granite. Into these flowed more molten rock, carrying minerals such as tin oxide.

The veins or "lodes" of tin so formed varied in width between half a metre and six metres. Often, the tin oxide would be very thinly scattered within the lode and possibly mixed up with other minerals such as quartz, tourmaline and chlorite.

Thus today's miners often work lodes that contain just 1 gram of tin oxide, known as black tin, for every kilogram of



rock. (The oxide contains about 60 per cent metallic tin, which is recovered only after the material is reduced in a smelter.)

Another problem is the degree of erosion, faulting and eruptions deep within the Earth that have affected Cornwall's rock strata since the mineralisation process ended some two hundred million years ago. The result is that lodes, which may once have been uniform and continuous, have frequently become twisted and prone to peter out suddenly. "Wandering" lodes have spelt misery and heartbreak for many a Cornish miner. "Following any Cornish lode is apt to be risky," sums up David Slater, head of the minerals strategy unit at the Institute of Geological Sciences. "And if you're starting without any cash flow, then you could find yourself in desperate trouble."

All of which would produce rueful sighs among the backers of a small Cornish mine called Wheal Concord. This started up in 1981 on the site of abandoned workings near Redruth.



Miners have to hack out tin-bearing rock from the surrounding granite (far left). An array of machinery features in the extraction process, assisted by manual techniques that have changed little over the centuries (right)



few years; and it has its sights set on expansion.

If the sale had gone ahead, Rio Tinto would have developed Wheal Concord, refining its ore in the modern processing plant at Wheal Jane a few kilometres away. But the multinational pulled out after deciding prospects were not good enough. "We spent a lot of money evaluating Wheal Concord but it didn't fit into our scene," says Brian Calver, Wheal Jane's managing director.

Since taking over Wheal Jane from Consolidated Gold Fields in 1981, Rio Tinto has spent several million pounds improving production methods. It has also applied for planning permission to extend the underground workings by several kilometres to explore a new deposit, which could double the mine's reserves of ore to about 4 million tonnes, enough to guarantee production for some 15 years. This ore contains substantial volumes of zinc and copper, which are produced as by-products of the more valuable tin.

The saga of Rio Tinto and Wheal Concord illustrates the "Catch 22" of Cornish tin mining. The deposits are, in the main, so marginal that large companies with financial muscle are required to exploit them. But as large companies have big overheads and do not like risky ventures they often do not want to become involved.

In the eyes of some observers, Rio Tinto has become a force

Nick Warrell, a civil engineer from Falmouth, raised £500 000 to exploit tin from existing tunnels 80 m and 110 m under the ground. (Cornish miners, following tradition, would put these depths in fathoms.)

Much of the 21 000 tonnes of ore that Wheal Concord's workers excavated was richer in tin than comparable deposits in Cornwall. But in November last year, the lodes became exhausted. The only way to keep the mine going would have been to spend perhaps £4 million on deeper tunnels plus new surface equipment. Warrell did not have this kind of money, so the mine closed, throwing 50 people out of work.

At one time, it looked as though Rio Tinto-Zinc, the giant metals company, would rescue Warrell by purchasing Wheal Concord. The company has a stake in all four existing Cornish mines; it owns Wheal Jane, the biggest works, while it holds 40 per cent of the shares in the South Crofty and Pendarves mines and has an 18 per cent share in Geevor (see Map). Rio Tinto has bought into all the mines only in the past



in Cornish mining for reasons that have little to do with the profitability of the mines. More significant could be that it wants to guarantee supplies of ore to its tin smelter—the only one in Britain at Capper Pass, near Hull.

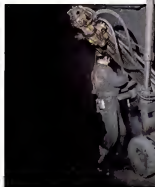
Modern technology does not play much of a part in the mechanics of digging the ore out of the ground. This has changed little in principle since mining first started in the county in medieval times. Before that, tin extraction followed either from metal “streaming”—collecting tin deposits from rivers, the flow of the water doing a reasonable job in separating the heavy tin particles from the soil—or from shovelling up the ore from lodes exposed to the surface.

Of course, one technical advance that emanated from Cornish mining played a key role in stimulating the Industrial Revolution 200 years ago. This was the invention of the steam engine, originally devised for draining water from the tin mines, but then adapted by James Watt for driving factory machinery.

In tin mining today, workers excavate tunnels or “drives” horizontally from a vertical shaft. Then they connect them by “stoping”—digging upwards or downwards in places where the tunnels cut through lodes, in the process dislodging the ore. The next operation is “tramping”, or the actual removal of the ore to the surface using wagons. The “stope”, or place from which the rock is dug, becomes, at the end of the operation, just a cavity in the rockface, at which point it becomes a “gunnis”. Dynamite is commonly used.

Because tin lodes are apt to end at any time, miners have to be continually ready to open up new levels or drives, and to extend new ones in a series of crazy changes in direction. The development of new levels or stopes, which are either simply for exploration or which will not produce any ore for perhaps three years, can eat up about a third of a mine's operating costs.

As a result of this activity, a three-dimensional model of a tin mine can take on the appearance of a twisted mass of



In a modern tin mine, trucks carry the ore along tunnels to the shaft (far left). To dig out the ore in the first place, miners use a combination of dynamite (left) and machinery such as drilling equipment (above). The finished product is tin oxide or “black tin” (below; left)





petrified spaghetti with shafts and tunnels splaying out in all directions. The tunnels in Cornwall's oldest tin mine, South Crofty near Camborne, run for a total of 160 km, about the distance between London and Birmingham. South Crofty has eight levels, the deepest 800 metres below the surface and at any time has 40 stopes in operation. Another of the mines, Geevor, is based on the cliffs not far from Land's End and is exploring reserves under the Atlantic.

Where today's technology plays a more important role is in separating the tin oxide from the ore in which it is found. Ore from underground is crushed and ground to remove the larger particles. Water is used to wash away sediments. Workers add chemicals to remove impurities such as sulphides. Then comes what is called gravity separation. This follows the same principles

Cornwall's two biggest mines—South Crofty (above) and Wheal Jane (left)—have become local landmarks. The remains of dozens of old workings with what is left of their engine houses (below) are a familiar sight in the Cornish countryside.



as a tin-streaming operation. Finely crushed particles of ore are fed as a slurry to what are called shaking tables, large vibrating platforms that separate out the particles according to their weight. The tin oxide, being relatively heavy, travels only a short distance when carried by a stream of water and can be channelled off from the waste.

A process called flotation is crucial in obtaining very small particles of tin oxide from the "waste" slurry that the gravitational technique discards. Flotation has become properly developed only in the past 30 years; it was certainly not available to the "old men" who ran the mines last century. In the process, a slurry of ore and water is mixed with a chemical that forms a layer around tin oxide particles, preventing them from getting wet.

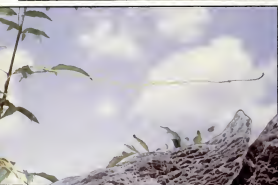
If the mixture is stirred vigorously, the tin particles form a froth on the top that can be scraped off. Flotation is important in separating particles of tin oxide less than about 40 micrometres in diameter. The chemicals have to be carefully selected so that they affect only the tin oxide and nothing else. Factors such as temperature and acidity play a crucial role in determining how well the process works. The most commonly used chemicals in flotation plants in tin mines are styrene phosphoric acid, tetrasodium dicarboxethyl sulphosuccinamate, and methylene phosphonic acid.

Wheal Jane has used flotation since it started up in 1971, as the deposits the mine works contain a lot of very fine cassiterite particles. South Crofty and Geevor are considering the process to prevent waste and increase output. Flotation will be an important part of the plant that Marine Mining is building at Gwiltian.

Also employing flotation is an unusual operation called Cornish Tin and Engineering. This runs a small works at Tuckingmill by the side of the Red River into which the South Crofty mine has ejected its waste further upstream. Following the reclamation principles of Marine Mining, the works collects particles from the stream and processes them to remove the tin oxide that South Crofty has discarded.

The enterprise, which employs about 20 people, produces about 20 tonnes of black tin per week. Richard Williams, the manager, says that flotation is "just a matter of common sense".

In another scavenging operation, a small company called Medway Tin scours the countryside for dumps left by the miners of old. The firm collects the waste in lorries and processes it at a plant in the village of Carn Brea, producing 5 tonnes of black tin per week. (The plant uses conventional gravity processing.) Such enterprises not only add a few more precious tonnes to the output of Cornwall's tin industry. They also extend the traditions of the area—the working over of old dumps by "dressers" has taken place since ancient times and will, no doubt, continue to do so long after the mines close down. □



Vines of dodder (*Cuscuta reflexa*) envelop a yellow elder (*Tecoma stans*), a native of Central America (above). The vine coils round a single shoot of *Tecoma* (far left), then grows out horizontally, perpendicular to gravity, until it reaches a new host. Then the parasitism begins again



1

Scanning electronmicrograph (SEM) of the tip of the American dodder (*Cuscuta gronovii*) showing rudimentary scale leaves which protect the lateral bud at its axil (left)



2

How the hormone controls the parasite

The dodder is one of nature's most accomplished parasites. It has launched a thousand folk tales; and now is proving a superb model for studying the hormones that control plant growth

S. Mahadevan

THE DICTIONARY describes dodder as a non-green, leafless, rootless, twining flowering plant, that parasitises other plants for its nutrients and water. The word is apparently derived from the Germanic *dotter* or yolk of egg, which is roughly the colour of the common European dodder, and is now used as a common name for all species belonging to the genus *Cuscuta*. The *Index Kewensis* lists more than 250 species of dodder and while some of these are possibly synonyms of the same species collected from different localities, the dodder appear to be native to all the large temperate and tropical land masses of the world. The relationships of *Cuscuta* are still uncertain; on the basis of its flower structure, most taxonomists have placed it in the Convolvulaceae, the bindweed family, but Arthur Cronquist, in his *Evolution and Classification of Flowering Plants* (1968), gives it its own family, the Cuscutaceae.

With their bizarre appearance and seemingly mysterious but treacherous way of life, the dodders have certainly latched on to human imagination as successfully as they do to the innumerable species of plants they parasitise, spawning fables, myths and fascinating names such as love vine, immortal vine, vine in the sky, beggar vine, strangleweed, devil's gut, scald and so on. An Arabic poet compares purposeless human qualities with kushooth—a dodder species from which the Latin *Cuscuta* is possibly derived—with the line: "He is like the kushooth; for he has neither root, leaves, fragrance, shade of fruit". Erasmus Darwin, grandfather of

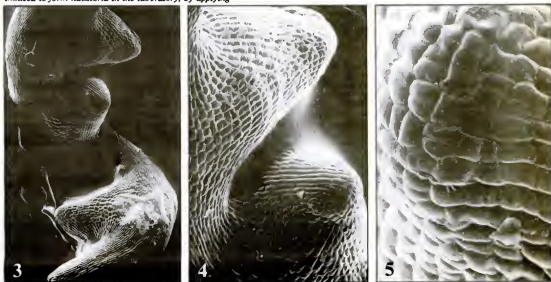
Charles, describes dodders in verse as "harlot-nymphs" which crush their prey in their coils much as the mythological serpents crushed Laocoon and his sons, while Indian myths grant unlimited wealth and the power of invisibility to those who find the roots of dodder. The dodders however are not without uses; Dioscorides the Greek and several Eastern *materia medica*s document the curative powers of the seeds of certain dodders in disorders of the digestive system. In more recent times dodder vines have been used as "bridges" to transmit certain types of viruses from one host plant to another, so rapidly spreading the infections.

No leaves, no roots

The dodder has no leaves and no connection with the soil after its seeds have germinated; the roots do not develop. The vegetative part of the dodder plant is an epiphyte (that is, a plant that grows on other plants) consisting exclusively of thread-like, often yellowish vines partly coiled around the stem of its host and partly draped over it or hanging free. Depending on the particular species, dodder vines range from very slender forms as fine as human hair to coarse ones a few millimetres in diameter. Extensive branching leads to numerous contacts with the host, and ultimately covers the host with a tangled mass of vines. During all this growth dodder obtains its nourishment from the host through numerous absorptive organs called haustoria which develop all along the coiled regions of the vine on the inner surface in

The scanning electronmicrographs in Figures 2 to 10 show the development of an haustorium of *C. gronovii* after treatment with the plant hormone cytokinin (benzyladenine in lanolin paste). In 2, the vine is showing coiled growth, one day after treatment with cytokinin. Such growth is not a prerequisite for the formation of haustoria: quite short, subapical segments of dodder can be induced to form haustoria in the laboratory, by applying

cytokinin. 3 shows the vine 72 hours after applying cytokinin; haustorial mounds are developing. The haustoria usually develop on the inner side of a coil, where the host would normally be. 4 shows two haustorial mounds in greater close-up, and in 5 we see the tip of a haustorial mound from even closer, with some recently divided cells



contact with the host. Each haustorium penetrates the host tissue and through this "living bridge" draws water and nutrients, much as a mammalian fetus draws its nourishment from the placental connections embedded in the wall of the womb. The dodder's ability to lead a parasitic life thus depends on its ability to develop haustoria, an evolutionary adaptation which in one stroke has rendered redundant the need for two major organs; the roots for supplying water and minerals and the green leaf for preparing food through photosynthesis.

Dodder propagates either from seeds or clonally from broken-off segments of the vine that accidentally come in contact with a fresh host. Several species, (such as *C. reflexa*) carry over from season to season by regenerating new vegetative buds from usually obscure remnants of the previous season still embedded in the host. It is this ability to regenerate that reduces many a garden enthusiast to tears when new flushes of dodder appear, as if from nowhere, on favourite hedges even after they have been pruned bare to get rid of it. Thus did the dodder acquire its image of immortality.

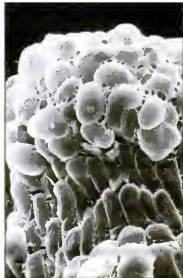
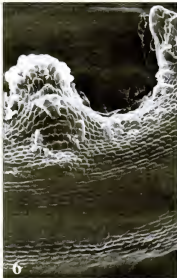
Reaching a host is tantamount to survival in dodder and several features in its development enhance this ability. The absence of root growth and thus of anchorage in the soil soon after the seeds have germinated reduces its expenditure of stored reserves and allows the seedling to be carried by physical agents such as wind or water. In the absence of expanding leaves, shoot growth is essentially the elongation of a cylinder, a geometry ideal for spanning distances while at the same time keeping surface area to a minimum and hence the loss of water by evaporation. The apex (tip) of the shoot continues growth by mobilising food and water towards itself from the older tissues behind. Dodder literally grows in front while dying behind. Its tip can stay alive and grow for many days, thereby increasing its chances of meeting a host.

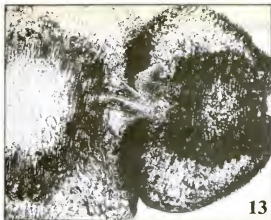
Like most twiners, dodder exhibits either equal growth all around its cylindrical axis, which yields a relatively straight vine, or grows unequally, which allows it to coil around and climb up a linear object such as a host plant. However, in dodder the production of a few such coils usually triggers the development of haustoria which eventually establish the supply lines with the host. Once haustoria become functional by delivering water and nutrients, the dodder vine once again resumes the free, "straight" mode of growth which leads to further contacts and allows the vine to spread.

The epidermal cells must divide and enlarge to cover the increased surface area as the mound grows. In 6, the epidermal cells at the apex of each haustorial mound are enlarging greatly in size and, after a further 72 hours, begin to separate along the lateral walls. 7 is a close-up of the left haustorial mound shown in 6; the epidermal cells are club-shaped, and enlarged radially. The cuticle covering the epidermal cells ruptures as the cells increase in size. 8 is a top view of two haustoria with fully enlarged and laterally separate epidermal cells, often called "prehaustorial cells". These cells normally press against the host surface and possibly soften it so that the "true haustorial" cells can penetrate and later grow through them. 9 shows the pebble-like cells of the prehaustorium enlarged, and viewed from the top; and in 10, some pre-haustorial cells are shown in even higher magnification, with extensive radial expansion and club-shaped tip. The odd shapes and bud-like protrusion suggests non-uniform weakening of the wall, which balloons out by increased hydrostatic pressure (turgor) within the cell



In 11 and 12, dodder is parasitising itself; autoparasitism. In 11, after two intertwined and self-parasitised vines of *C. gronovii* have been separated, two haustorial mounds are seen lying in the spiral grooves created by the partner vine that has been pressed closely against it. An enlarged view of the haustorium, 12, shows a partly raised mound flattened at the top by the pressure of the partner vine. The true haustorial cells at the centre of the flattened mound have jagged edges. They had penetrated the partner vine in order to drain water and nutrients from it, and been torn when the vines were separated





In 13 we return to light microscopy: a photomicrograph of a cross section of two autoparasitising vines of *C. reflexa*—each in the process of staking a haustorium into the other. It is not known whether such haustoria are functional

The simple morphology of dodder makes it a very convenient experimental model for studying development since all parameters of growth and differentiation are strung out in space as well as in time along the linear axis of a cylindrical vine. During such a study, a serendipitous observation was made a few years ago in our laboratory at Bangalore. We found that cytokinins, a class of plant hormones, could induce the formation of numerous haustoria on "free" dodder vines in the absence of a host, adding a new dimension to the problem of haustoria development. What is most interesting is that the application of a single chemical triggers a whole series of developmental events, from the manifestation of coiling growth to the formation of haustoria.

The scanning electron micrographs (Figures 1 to 12) depict the stages in the formation of haustoria following the application of benzyladenine (a synthetic cytokinin) as a

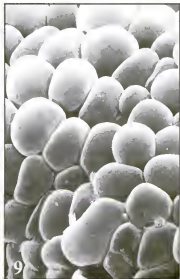
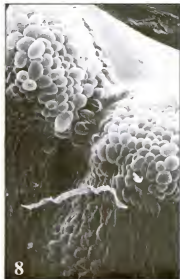
lanolin paste just behind the tip of free vines of a North American dodder (*C. gronovii*). Within 24 hours of treatment the growth pattern changes from the "straight" to the "coiling" form and in 72 hours numerous haustorial mounds can be seen. The conical mounds, initially smooth in appearance at the apex, become rough in appearance as the epidermal cells enlarge and separate along the lateral walls, yielding club shaped cells. These cells, often called "prehaustorial cells", are the ones that press against the host, and possibly soften its surface. Later, true haustorial cells push through the prehaustorial cells, grow through the host and eventually establish contact with the host's food-conducting tubes.

Even small, subapical segments of dodder (*C. reflexa*), incubated in glass dishes, can produce haustoria when treated with cytokinin. Moreover, the application of two other classes of plant hormones, auxin and gibberellin, inhibits the formation of haustoria, which suggests an interplay of hormones in their development.

Further studies indicate that these hormones can control the nature of growth in these segments. Cytokinin alone or in combination with low levels of auxin promotes "coiling" growth, while high concentrations of auxin promote "straight" growth. Gibberellin, shown to be necessary for continued growth of dodder vine tips in aseptic cultures, also interacts with cytokinins and auxins in the growth of subapical segments; it augments their effects.

In short, by manipulating the relative concentrations of applied hormones, segments from the appropriate regions of the dodder vine can be made to mimic *in vitro* the various patterns of growth seen *in vivo*, including the formation of haustoria. The question now to be answered is whether endogenous hormones similarly regulate patterns of growth and the formation of haustoria in the intact dodder and if so, how the stimulus of contact with the host is coupled to the action of hormone. □

S. Mahadevan is professor of biochemistry at the Indian Institute of Science, Bangalore. Professor Mahadevan would like to acknowledge the efforts of Gopinadhan Paliyath, Indra Rajasekhar, T. S. Ramasubramanian and Ramesh Maheshwari, at Bangalore. Scanning Electron Microscopy was made possible through the courtesy of William Samsonoff and S. Anand Kumar at the N.Y. State Department of Health, Albany. *C. gronovii* was supplied by Fred Truscott (SUNY, Albany). Professor Mahadevan also acknowledges the encouragement of Professor David Hall of King's College, London University.



Is Big Brother reading your meter?

Mains signalling is both a domestic luxury and a way to cut industry's energy costs. It also offers great powers to the electricity, gas and water boards

Tony Durham

MAINS WIRING has suddenly become a sought-after communication channel. At least three distinct groups want a share of the scarce resource. Industrialists want to switch machines and lights remotely. At home, people want to dim lights or to switch them on and off during long holidays. And electricity, gas and water boards are involved in an unprecedented joint effort to develop ways to read customers' meters from a distance. The electricity industry has an extra desire: to switch consumers' equipment on and off from a central point. Electricity boards already have the technology to switch selected devices off in your home—or even disconnect you completely—by remote control. But it would take 10 to 20 years to convert every dwelling. Spot checks on any consumer's use of electricity would also be possible; and as the Electricity Council's Energy Management Task Force said in its 1981 report: "the remoteness and automation of the meter reading process has 'Big Brother' overtones."

Despite these overtones, the Electricity Consumers' Council has reacted positively. The consumer body's report *New Metering Technology*, published last month, speaks of "an opportunity . . . that the industry should welcome and to which it should respond rapidly and enthusiastically". The big attraction is lower or, at least, less rapidly-escalating electricity bills. An article in *Electrical Review* estimated that the industry could save £1000-1400 million per annum by using the technology to spread the demand for electricity. The Electricity Consumers' Council (ECC) agrees that savings "could be significant" even if they do not reach the £1000 million mark.

The principle costs, according to the Energy Management Task Force, would be £80-120 for the new equipment in each home, plus an installation cost similar to that for a conventional meter and timeswitch. Consumers might be asked to pay for any additional rewiring—a potential point of contention.

To save the most money, consumers would have to change their habits to shift the times of peak demand. The biggest daily peak comes around 5.00 pm, as homes switch on before industry switches off. There has been little research on the way consumers would respond to the various kinds of incentive that could be built into the electricity price structure.

Consumers could be offered many different kinds of tariff, for example:

- time-of-day tariff: perhaps with several different charge bands applying to different times of day.
- spot-pricing: frequent, unscheduled price changes through

the day, to reflect true generating costs.

- interruptible tariffs: cheaper electricity on the understanding that the supplier could disconnect some equipment for short periods by remote control.
- maximum demand tariff: cheaper electricity on the understanding that consumption does not exceed, say, 10 kW at any time.

Alan Plumpton, deputy chairman of the Electricity Council takes the view that consumers, and women in particular, could not cope with "spot pricing". He said: "What is the housewife going to do when she is told that the price of her electricity has now reached 10 pence per unit. And what is the poor woman to do if her water heater is already turned off?" Plumpton denied *New Scientist's* charge of sexism.

"I'm not saying housewives are unintelligent" he said. "It's a question of whether they can be bothered. I think it's a function of what incentives we're going to give them."

Toby Harris, author of the Electricity Consumers' Council report, believes people will adapt. "People have adapted to telephone

charges being more during the morning than during the night. Potentially the same could happen with electricity. You could put the tumble drier on at 2.30 instead of 4.30 in the afternoon. In practical terms it may not make much difference to consumers when they do that." However he disagrees with certain "enthusiasts from the supply industry" who say that people should reschedule their cooking.

Field trials to start

Interruptible tariffs will soon be tested in two years of field trials costing about £1.5 million. The main targets are water heaters and freezers. (Cheap night tariffs will continue to be available primarily for storage heaters.) The electricity industry does not intend to make a habit of cutting off people's lights, cookers or television. Freezers and immersion heaters will be switched off for no more than 15 minutes at a time during peak-load periods. This could cause minor inconvenience when, for example, a family wants several hot baths in succession.

Technically it would not be hard to give consumers the freedom to override the electricity board's switch-off signal, by paying an extra charge if necessary. Toby Harris of the ECC said: "I think consumers will feel happier if they have an override facility. But I am not sure how much they will actually need it."

Maximum demand tariffs, already applied to some industrial consumers, would raise fresh questions for domestic consumers. What happens if you exceed your limit? A surcharge? Total disconnection? Or progressive



The Thorn Mainsborne (top) receives and sends instant signals about your power consumption as does Seeboards' CALM (above). GEC's Mainslink (left) switches equipment within a single site

disconnection of low-priority appliances? The South Eastern Electricity Board (Seeboard) is developing an "intelligent plug" which allows consumers to set their own priorities for their various appliances. Messages for the intelligent plug are carried by signals on the house wiring.

The intelligent plug could take automatically all those little money-saving decisions that Alan Plumptre fears consumers may not bother to take for themselves. But it has another, sterner aspect. People who are behind with their electricity bills could find themselves restricted to a consumption of as little as one kilowatt. Big Brother again? Not necessarily, for as Seeboard spokesman Derek Liquorish points out: "The alternative is disconnection."

Remote control via the mains, independent of any public utility, is also possible within a single site or building. It can save a large office or factory thousands of pounds in wiring costs: lights and heaters no longer need individually-wired switches costing up to £50 each.

Preventing interference

There could well be a problem of interference amongst all these users. One simple way to prevent it would be to fit a broad-band electrical filter next to every electricity meter. The filter would block all signals of frequencies above, say, 10 kHz. That would give the electricity supply industry the free run of the distribution network, while consumers could signal in any way they liked on their own mains wiring without bothering anyone. Who could possibly object? First, the electricity supply industry. It wants to keep a clear signal path beyond the consumer's meter for its own purposes. And second, the manufacturers of inexpensive

domestic remote-control systems. Their sales point is that the equipment can plug straight in without altering the house wiring.

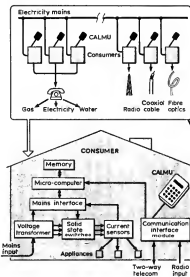
This is why filters are mentioned only once in the draft code of practice for very low frequency (VLF) signalling, published last January by the Association of Control Manufacturers (TACMA). In September 1981 this trade association brought together equipment manufacturers, Home Office and electricity council representatives in a study group to sort out some of their potential conflicts. The group's main proposal is to divide the available frequencies between 40 and 150 kHz into four bands (A, B, C and D) for different classes of users. This could help to prevent interference, in the absence of filters.

The draft code has been presented to the British Standards Institution as a possible basis for a new British Standard. But, as TACMA admits freely, "there are still areas where further work is essential."

One such area is glaringly obvious. Band A, intended for the use of the electricity supply industry, does not exist. No frequencies are allocated to it. There are no spare frequencies for it between bands B, C and D. Unofficially it is expected that when finally allocated, Band A will coincide with Band D (40-90 kHz). But the London and East Midlands electricity boards are involved in field trials using frequencies that cover almost the entire spectrum available for mains signalling. If the bands are reshuffled, the trials will have been of little practical value.

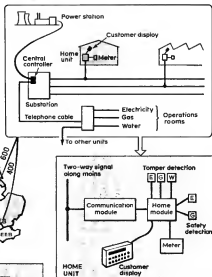
Another unresolved conflict concerns possible interference between domestic or commercial users who have installed systems in neighbouring premises. TACMA's provision

CALMS

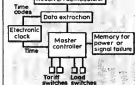


Electricity boards are experimenting with metering technology (map) in the Midlands, East Midlands, London and the South East. Figures show the number of homes connected to each system by the boards. CALMS works by phone link; it can also work other ways. CALMS (CALMU is the consumer's control unit) and Mainsborne can directly debit your bank account

Mainsborne



Radio-teleswitching signals are broadcast on 200 kHz by three Radio 4 transmitters. Later this year, 1,500 homes in the UK will start an experiment with the system



Radio-teleswitching

for two separate bands for continuous and intermittent transmission (Bands B and C) should prevent mutual interference between these two major types of system. But interference must be prevented between adjacent systems of the same type.

The obvious solution is to divide each band into channels, in the manner of Citizen's Band radio. Further protection can

TACMA's proposals on the VLF spectrum

Frequency	Band	Use
40-90 kHz	D	Consumers with own substation (Eg: GEC Mains-link.)
90-110 kHz		Unused. (Second harmonic could interfere with BBC Radio 4, 200 kHz.)
110-125 kHz	B	Continuous transmissions. (Eg: MK Response.)
125-140 kHz	C	Intermittent transmissions. (Eg: Home Automation Ripul; Superswitch Command Centre.)
140-150 kHz		Reserved by Home Office
Unallocated	A	Electricity boards, remote metering and load management. (Eg: Thorn EMI Mainsborne.)

Frequencies below 40 kHz are already used for communication on construction sites. Use of frequencies above 150 kHz is restricted by British Standard 800:1977 on radio interference.

be provided in Band C by the use of "address codes". Ideally, each user's equipment would respond only to signals containing that user's unique address code. In practice, address codes (like car keys) are not unique. One manufacturer, Superswitch, provides 16 possible address codes to ensure that neighbours can avoid mutual interference if they want to. But there must be many more codes—thousands or millions—if each system is to be truly secure against deliberate mischief.

In Band B, address codes alone could not prevent interference. Band B is intended for systems which transmit continuously. One system could jam another, even if the address codes did not match. The only protection would be for neighbours to use different channels or to fit filters.

The Citizen's Band fiasco has shown the importance of establishing standards before substantial amounts of equip-

ment are sold. The makers of mains signalling equipment hope that business will grow rapidly in the next few years. If that happens, it is in the industry's interest to seek prompt solutions for its remaining problems.

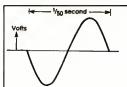
Electricity boards have many decades of experience with mains signalling. Signals transmitted through the mains controlled some London street lamps in the 1940s. Equipment was possibly used to trigger air raid sirens during the Second World War. Early trials used powerful audio-frequency "ripple" signals. During the past 40 years this approach has been tested sporadically in Britain and extensively on the Continent.

A somewhat different system simulated the effect of momentarily jamming an iron bar across the terminals in the substation. Not surprisingly, it caused lights and TV sets to flicker. A more refined technique called Cyclocontrol replaced this system in the early 1970s.

GEC developed Cyclocontrol in Britain. It is installed in at least seven countries. Electricity companies use it to switch off certain loads, such as water heaters, at times of peak demand. Consumers can benefit because the heaters then use more of the cheaper off-peak electricity, and less of the expensive kind.

Electricity, gas and water companies have sought many years for a way to read meters without visiting the customer's premises. None of the older mains-communications techniques can provide the necessary two-way signalling between consumer and supplier. What is needed is a transmitter sufficiently cheap, compact and low-powered to be installed in every home.

Such a transmitter became feasible with the advent of large-scale integration (LSI)—the art of putting thousands of transistors on a single silicon chip. With LSI chips it is possible to generate, and detect, elaborate codes so distinctive that



Ideal waveform of 50 Hz supply

The market takes off

THE market for mains-signalling installations is becoming more varied as it grows. "Control your entire home from your pocket" enthused an American advertisement in 1979. The product, the Space Pager, was one of the first to offer remote control of up to 16 electrical devices anywhere in your home, by signals transmitted through the house wiring.

Manufacturers now look beyond houses to shops, hotels, offices and industrial sites. In this new, commercial market a major sales point is the energy saving that is possible with central control of heating and lighting, either manually or according to a timed program. By comparison, specially wired-in control systems are costly and inflexible.

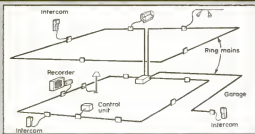
At least 28 companies in the United Kingdom are developing or producing mains-signalling equipment. There is a similar amount of activity in the United States, Japan, Canada, France, Germany, Switzerland, Holland and Sweden. Most manufacturers stress the "plug-in" convenience of mains signalling, but some systems must be wired in by an electrician. A typical domestic system has a central control unit with (in Britain) a 13A plug on a trailing lead. Plug it in anywhere in the building, and by pressing buttons you can switch appliances on and off, or dim lights,

either immediately or at preset times. Appliances plug into slave units which may resemble oversized 13A adaptors.

BSR was one of the first British firms in the market, the United States market that is, with its X-10. The unit, which was also designed in the United States, is available in Canada, Japan and most of northern Europe. It has yet to appear in Britain: BSR does not see sufficient demand in the UK to justify manufacture of a converted system. Other British firms disagree with that policy.

Home Automation's "Ripul" combines mains signalling and an infra-red remote control, like that needed to change television channels. In fact, the company has ambitions well beyond the "home" market. It has supplied a system with 500 slave units for Lloyd's Bank's headquarters at Canon Street, London.

Superswitch, part of the MK group sells its Command Centre at £139.95 for a basic



The mains can carry on-off, dim or voice signals sent from a central control point, at home or in commerce

set-up. Its slave units can answer back: they allow a shop of office manager to check at one look that everything is switched off before leaving at night. MK Electric's Response is a more sophisticated "answer-back" system based on the same technology. It will go on sale this summer. The company's marketing pitch will be at hotels, medium-sized offices and factories, and similar premises. A typical set up costs less than £1000 and MK aims to price itself into a new market between simple time switches and expensive custom-built computer-based energy management systems.

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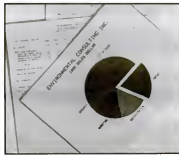
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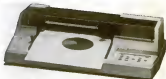
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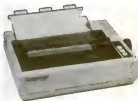
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REVIEW

Astronomical achievements out of this galaxy

EDWIN HUBBLE (1889-1953) was probably the greatest observational astronomer since William Herschel. Indeed there are interesting similarities between these two. Herschel started life as a professional musician, Hubble embarked upon the legal profession. But both found themselves possessed of a consuming interest in astronomy, to which in due course they devoted the rest of their lives after disposing of other distractions—in Hubble's case, his law, and national service in two world wars. Both exploited to the utmost the greatest telescopic resources of their times, and for both many of their discoveries resulted from massive programmes of systematic investigations.

More than anyone before him, Hubble extended the domain of astronomy beyond the confines of the Solar System to the whole Galaxy; Hubble extended it beyond the Galaxy to the "realm of the nebulae"—presumably to the whole physical Universe. But of course there were differences—besides the fact that Hubble had been an Oxford Blue in athletics. Herschel worked always by himself, while Hubble worked in professional observatories that were the world's finest for his kind of astronomy. This book is a first-hand account of the most tremendous enlargement of astronomical science, written by its foremost pioneer.

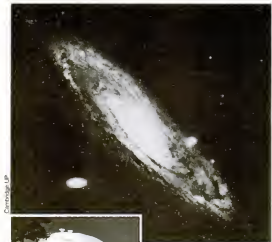
It seems right to see Hubble's greatness in recognising splendid opportunities and pursuing them with utmost devotion and superb vision. Milton Humason who worked with him for over 30 years called him a "brilliant leader" and wrote, "He was sure of himself—of what he wanted to do, and of how to do it."

Using the 100-inch telescope on Mount Wilson, in 1923 Hubble identified for the first time a cepheid variable star in a spiral "nebula" (M 31 in Andromeda), and proceeded in the next few years to make similar discoveries in several other such "nebulae". They gave reasonably valid distances for these objects. Once and for all, these were shown to be systems comparable with our Galaxy and right outside it. Such was Hubble's entry into the "realm of the nebulae".

He went on to obtain plates centred on about 1300 selected

The realm of the nebulae
by Edwin Hubble, Yale UP, pp 207, £25

William McCrea



Using the Mount Wilson telescope, Hubble identified a cepheid variable star in the Andromeda galaxy

areas scattered uniformly over 75 per cent of the whole sky, on which he was able to recognise some 44 000 galaxies down to apparent magnitude about 20. From this material he felt justified in inferring that the universe of galaxies is isotropic about ourselves, and in due course, in inferring that it is homogeneous in the large.

A by-product was his discovery of the "zone of avoidance" and his extensive investigation of obscuration by interstellar matter in the Galaxy. He developed his methods for estimating distances by using step-by-step cepheid variables, novae, blue giant stars... entire galaxies as standard candles. In the course of the work, Hubble set up the classification of galaxies displayed in his famous "tuning-fork" diagram, which has been used ever since.

Then in 1929, he announced his most astonishing discovery—that of what immedi-

ately became known as "Hubble's law of redshifts". It was the empirical discovery of the expansion of the Universe. In the years following, along with Humason, he added greatly to the observations on which his "law" was based. Also he accumulated extensive statistics of luminosities of galaxies and other parameters, and with notable resourcefulness he estimated their masses. He initiated far-reaching studies of the clustering of galaxies.

All this Hubble surveyed in *The Realm of the Nebulae* which, be it noted, he wrote only about half-way through his astronomical working life. He went on to do much more, but that is another story.

The book, which appeared first in 1936, is the publication of Hubble's (eight) Silliman Lectures in Yale University, along with a preface and introduction in which, incidentally, he explains why he spoke of nebulae rather than galaxies. It is a serious, systematic account written for the general reader, professional without being technical. All the abilities Hubble had exercised in doing the astronomy he here applied to producing a model presentation.

Although Hubble's work (with subsequent numerical amendment) has been the principal empirical basis of cosmology, this is not a book about cosmology but about astronomical observation beyond the Galaxy. Only in the last few pages is cosmology mentioned explicitly, although Hubble was deeply interested in it.

In the cause of historical



justice, it should be noticed how he seemed always to feel obliged to express caution about too readily assigning to the cosmical redshift all the attributes of an ordinary velocity shift; at the same time he seemed to wish not positively to offer any alternative.

It is now well known that distant galaxies are probably about 10 times farther away than Hubble inferred. This is largely because he was mistaken about two of his standard candles: his cepheid variables had characteristics somewhat different from those he assumed, and some of his brightest "stars" were actually highly luminous bodies of ionised hydrogen. But the general observational procedures laid down by Hubble have been followed by his successors to this day. Some of all this is mentioned in the graceful and perceptive foreword by James Gunn of Princeton University, the addition of which is the single change in this 1982 reprint.

The book is a classic. But who will read it? Of all present-day astronomers who quote Hubble's classification of galaxies, Hubble's law or the Hubble constant, one questions whether any have read a line of Hubble's writing. Now that this book is so readily available one suggests as a required first question in any PhD oral in astronomy, "Have you read *The Realm of the Nebulae*?" □

I HAVE several times told the story of the lady who came up to me at the end of one of my lectures on the relationship between science and music and said, "It's all very well doing all these scientific tests on musical instruments but can you explain the tingle in the spine that some music produces?" My reply was, "No, but I feel it too!"

I was therefore delighted to read in chapter three that the author, talking about oversimplified reasoning in music says, "... it does not explain why I respond with goose-pimples to Bach's *Kyrie* every time I listen to it." Indeed I hoped that this book might begin to give some clues about the origin of the tingle or the goose-pimples; but I was disappointed.

In fact I am sorry to say that many aspects of the book are disappointing. Of course—like the curate's egg—parts of it are excellent. And, thankfully, unlike an egg, the less wholesome bits do not detract from the value of the rest!

The origin of the volume is the third workshop on the Physical and Neuropsychological Foundation of Music held at Ossiach, Austria, in August 1980. Sixteen of its 20 chapters are based on papers presented at the workshop and the remaining four were specially invited. The preface indicates that the three main themes are, first, music and language, secondly, the perception and production of rhythm and, thirdly, the contribution of computer analysis to the understanding of musical processes. It concludes with the statement: "The book is dedicated to all those interested in how music functions. And if this book sparks interest in the reader to make his own contribution towards achieving these goals it will have been especially successful."

The word "sparks" is well chosen—though whether fortuitously or deliberately I am not sure. I remember an Oxford don complaining that he was tired of hearing the claim that universities should aim to produce "rounded" people: she wanted them to have sharp corners that would interact and strike sparks.

A few chapters of *Mind, Music, and Brain* are stimulating and produce the right sort of sparks; but others jar either because they are couched in long-winded jargon, or because they set off with a title and intent, which lead one to expect something new in the way of results, but then degenerate into vague speculations.

The book gets off to a good start and the first chapter is one

Who puts the tingle into music?

Music, mind and brain
Edited by Manfred Clynes, Plenum, pp 430, \$39.50

Charles Taylor



of the most stimulating—though I do not necessarily agree with all of it. It is good because it is written in friendly, ordinary language and where jargon creeps in, it is explained.

The question of the distinction between "mind" and "brain" is a controversial one: is there, for example, an "I" that is fooled by contradictory signals from the brain when we witness an illusion? The author suggests that there are, in fact, many different "agents" in the brain some of which are "feature finders", some "analysers", etc. I have read many works on the psychology of perception that

are difficult to follow, but this chapter is immensely readable and compelling.

The chapter on "Speech, song and emotions" interested me: "Perceptual onset of musical tones" and the chapter on electronic music "as a bridge between psychoacoustics and music" both contain some interesting ideas and are well presented.

But the chapter, entitled "A computer model of music recognition"—whose title whetted my appetite considerably—proved to be little more than a pious hope that studying the way a computer can be programmed to recognise music

might help to understand the way the human brain does it.

The book is accompanied by a "sound sheet", that is, a set of illustrations on a playable plastic disc. The trick in presenting aural demonstrations to an audience is to explain what they will hear, what they should listen for, and what its significance is before the demonstration and then to make a further comment afterwards. The descriptions are rather unhelpful and, even after several hearings, there are some tracks that do not make their point well. The idea is splendid, but it could have been so much more impressive with a little extra care in the presentation.

For whom is the book intended? The flysheet suggests that it will be of particular interest to the neuropsychologist, the neurophysiologist, the linguist and thoughtful musicians. In fact the orientation is very much towards psychology and I doubt whether many musicians would find it useful. The viewpoint is somewhat narrow and there are several controversial areas where the presentation is very one-sided.

Nevertheless, the book contains some useful and interesting material and is certainly not a book to be ignored. Perhaps my slightly jaundiced view stems from the fact that I was expecting that a book based on a workshop on the physical and neuropsychological basis of music would contain some physics, or at the very least some reasonably quantitative science rather than somewhat vague speculations. □

Juggling with magnetic doughnuts

Unconventional approaches to fusion
edited by B. Brunelli and G. G. Leotta, Plenum, pp 526, \$65

Michael Kenward

AS SCIENCE gets nearer to proving that thermonuclear fusion is scientifically feasible, concern grows as to the best machine to build. Perhaps this is a reflection of the problems that have plagued nuclear fission. In Britain at least we have spent two decades arguing about what type of nuclear reactor to build. Could it be that the fusion community is trying to solve this problem early on? Or could it be that the front-runner in the fusion race does not look very promising as the basis of a reactor?

The debate is about what sort of magnetic container to build to hold together the incredibly hot gas (plasma) in which fusion can take place. The topic was the focus of a meeting held at Erice in Italy in March 1981, and this

book collects the papers on alternatives to the tokamaks that at present dominate fusion.

Naturally there is a paper on the tokamak. The problem with this "magnetic doughnut" is that you have to build a huge machine to produce the energy needed for a power station. Indeed, the machine is so massive that a tokamak reactor would need something like 17 times as much material to produce the same power output as a pressurised-water reactor. Is it any wonder then, that fusion researchers are looking for more efficient fusion machines?

Unfortunately, as this book points out, some of the alternatives may look good on paper but they have a long way to go before they can match the tokamak. To a certain extent

these papers give an over-gloomy impression. That is partly because the editors have not included anything on the "mainstream" alternatives to the tokamak—stellarators and tandem mirrors for example.

As the title says, the book is devoted to unconventional approaches—some would use the word "eccentric"—to fusion. The approaches have names like *extrap*, *linus*, *intrap* and *spheromak* (billed as *speromak* on the contents page). Most have yet to make the transition from paper to hardware.

None but the dedicated fusion watcher would want to read what is essentially a conference report, even though it does contain a scattering of important insights into the prospects for fusion. But at least the fusion community needs such volumes to remind it that at the end of the day the scientific juggling will come to nothing if it does not lead to a convenient and not too expensive source of electricity. □

THE HISTORY of belief in the supernatural over the past hundred years is studded with the names of famous illusionists who have sought to prove that much-vaunted miracles were nothing more than conjuring tricks. Robert-Houdin, J. N. Maskelyne and Harry Houdini all unmasked fraudulent psychics and repeated—and embellished—their tricks on stage in front of admiring audiences.

James (The Amazing) Randi has been a member of this select set for many years now. He has met with precisely as much, and as little, success as any of his celebrated fellow-magicians. There can, however, be few less satisfying occupations than that of the professional unmasker of psychic frauds, for, whatever the facts may be, no undeniable fact is that people deeply want to believe these things.

When I was researching this subject, the opening exchange of conversations was so invariable that I learnt to recite it at once to save time. Having established what I was looking into, my interlocutor would ask, "And have you found anything which makes you believe it's true?" I had to say that I had not.

"PLUS Jane Corbin and Lawrence McGinty with news about science, technology and medicine," TV Times announces as part of every Wednesday's Channel Four news. Excellent. We were once promised something of the sort from Anna Ford back at ITN, but it never happened. So this is the first news bulletin to allocate a regular slot for science and allied matters. How's it working out?

Rather well, with some odd wrinkles, which may be my verdict. On the one hand C and M contrive items which encapsulate, within 3 or 4 minutes, all you need to know about subject X. There was an excellent example some weeks ago, when M told us about nuclear-waste dumping at sea—how much, what it contained, where it was ditched, how dangerous it might be, what was known and what wasn't—all explained quickly, painlessly, economically.

One of the oddities, though, is when C and M slip across a piece that has little or nothing to do with the high-tech graphics which preface their speciality corner. Last week (13 April) was a case in point. There had been no let-up in Mount Etna's eruption. C vouchsafed. The lava had already damaged a tourist complex and put a cable car out of action. End of item. Fine—just like an endpiece from

Sceptic fights to save the world

Film-flam—psychics, ESP, unicorns and other delusions

The truth about Uri Geller

by James Randi, *Prometheus*, pp 342, £7.45 and pp 235, £6.95

Ruth Brandon

"What? Not even one thing?"

If evidence of this deep desire to believe in the supernatural were needed, it is amply available in Randi's books. They are full of old and oft-exploited stories. Arthur Conan Doyle's experiments with fairies. Professor Johan Zöllner's trips into the Fourth Dimension courtesy of Henry Slade—these not only provide illuminating parallels with current happenings but still, after myriad exposure and confessions, retain their adherents.

Indeed, once a psychic has become established it seems that nothing—not the most detailed confession, not the most damning exposure—can dent the confidence of believers. And, not content with continuing to believe the evidently fraudulent, they do their very best to draw the exponents into the net. Almost every conjurer who has taken a *parti pris* in this field has found himself accused of

possessing psychic powers.

What could be more infuriating? Randi, like Houdini, like Maskelyne, is enraged; and if his stories recall theirs, so does the



Was Geller an illusion?

tone of his book. He is embattled. The world is determined to believe benighted rubbish: he is determined to save it from itself.

Waving his cheque book for \$10 000 (ready to pay to anyone

who can produce convincing psychic phenomena) he sets out on the exposure trail. The Bermuda Triangle, Erich von Daniken, transcendental meditation, Jean-Pierre Girard and, of course, Uri Geller, are shown up for frauds. Randi describes their methods in detail, except where some professional magicians' secret would otherwise be exposed. He shows exactly how a legend can be created, whether of pre-Columbian space visitors or of ship-gobbling ocean areas. It is fascinating and it is convincing.

Yet von Daniken is a millionaire and Randi is not. No one is more aware of this than publishers, to the sceptics' fury. Millions are to be made out of books proclaiming that the occult is real. By contrast, books such as Randi's have a hard time finding enthusiastic editors.

Randi is not contented to probe into why this should be so. Nothing so namby-pamby. He is champion of the sceptics, and he sallies forth with his banners flying. On past form he need fear no let-up in the fight. There are none so deaf . . . □

*Prometheus Books, 10 Crescent View, Loughboro, Essex IG10 4 PZ.

Experts in the limelight

News at Ten—but where was the science angle?

Much more typical of C and M at their best were reports on the use of a "highly sophisticated substance", Fomblin, to preserve the stone of St Martin's Cathedral in Lucca, Tuscany, and on Robin Baker's exploration into human navigation. I confess to not immediately grasping one reason for the cathedral's decline ("Pigeons can be kept off the facade by netting but few sink into the porous marble"). And the precise purpose of Fomblin in the space shuttle escaped explanation. Still, this was a tidy, interesting account of a clever gambit from the University of Florence.

M did well with Manchester University's Dr Baker too, showing a blindfold, calf-muffled child guessing compass bearings after being twirled in a rotating



Bernard Dixon

chair by a Lady Di look-alike. The results looked convincing. Equally important, the need for rigour in approaching a problem of this sort came across nicely. Why then omit to inform viewers that Baker's other tests, involving bus loads of students direction-finding after tortuous, blindfold journeys, have been repeated in the United States with negative outcome?

For real controversy last week one turned to the often uncontroversial Horizon. Other reviewers have commented on the harrowing realism of Madness on trial (11 April), which portrayed Mary, a schizophrenic who had murdered her mother, and followed her trial and psychiatric assessment. The risky formula of having Mary played by an actress, being interviewed by a psychiatrist playing herself, was an unquestioned

success. More time should have been given to expert uncertainties and disagreements about the nature of the disease (reviewed as recently as last October by Solomon Snyder in *The Lancet*). Otherwise it was hard to fault this sensitive examination of the interface between mental illness and the law.

The most telling passages, indeed, were those recapitulating the Ripper trial—which uniquely in recent years illustrated the harshness of that interface, for all our liberal deccencies. Confronted with a murder charge, defence lawyers resolved to try for a verdict of manslaughter on grounds of diminished responsibility. The prosecution agreed, altering the charge to manslaughter because their psychiatrists too thought Peter Sutcliffe schizophrenic. But the judge insisted, in the public interest, on a murder trial.

So the prosecution handed their expert witnesses to the defence, and pulled their evidence to pieces. Cross-examined, luckless psychiatrists found themselves cast as gullible fools tricked by Sutcliffe. As this programme made awfully clear, the atmosphere was not conducive of dispassionate assessment.

Hilary Henson, sometime most dour frontperson, deserves high praise for writing and producing a superb *Horizon*. □

This week's contributors

William H. McCrea FRS is professor emeritus in the Astronomy Centre at the University of Sussex.
Dr Charles Taylor is professor of physics at University College, Cardiff.
John McCormick works for Earthscan and is researching a thesis

on the history of the conservation movement.

Michael Turnbull is a lecturer in general education in Scotland, with an interest in computing.

Ruth Brandon is author of *The Spirituists* (Weidenfeld, June 1983).

LETTERS

Nuclear propaganda

Your patronising attitude to CND (Comment, 7 April, p 2) is a sad contrast to your excellent Easter issue. You refer to "anti-nuclear propaganda" and CND's failure to take "a reasoned line".

These statements betray either an ignorance or a distortion of both the tenor and depth of the publications that have emanated from the anti-nuclear movement in recent years. To call Duncan Campbell's work on civil defence of the Cambridge University Disarmament Seminar's *Defended to death* either propaganda or unreasoned is totally unfair.

The description of the majority of demonstrators as "self-righteous pigs" is just silly. To accuse us of thinking we are the only ones interested in peace is to reiterate mindlessly a routine anti-CND slogan. Am I right in suspecting that perhaps all is not sweetness and light on this issue among the *New Scientist* team? You really do seem to be trying to have your cake and eat it: being anti-peace, anti-Thatcher, anti-Foot, anti-SDP/Liberal Alliance and anti-CND—all at the same time! *Graham Richards*
Cambridge Wells

It is surprising that *New Scientist* should have convinced itself that the nuclear weapons policy of the SDP is "indistinguishable" from that of the government.

(Comment, 7 April, p 2). An SDP government would:

1. Cancel Trident.
2. Put to the House of Commons the deployment of American cruise missiles on British soil.
3. Have a British finger on the safety-catch of the missiles.
4. Draw battlefield nuclear weapons back from the front line.

The Conservative government's policy is the opposite on all four points.

Wayland Kenner
House of Lords



Davy defended

An article in the issue of 10 February entitled "Why the safety lamp increased accidents" (p 352) is headed "Today's myth has it that the Davy miner's lamp brought safety to Britain's coal pits. The reality is exactly the opposite. The introduction of the lamp allowed more coal to be dug and more profits to be made. But more miners died in the process."

A bigger slur on the memory of Sir Humphrey Davy is difficult to imagine.

When the Davy Lamp is taken into air that contains more than 5 per cent of firedamp, or if the air passing the lamp is suddenly contaminated to that extent, the air inside the lamp explodes and puts out the light but the mesh prevents the explosion being transmitted to the air outside the lamp. Thus although the miner is put in the dark he is alive to tell the tale.

The scourge of firedamp explosions caused by the miners' lights should have dwindled to nothing after the lamp came into use. Instead the figures went up and up, but this was due to Davy's lamp? Of course not. Much of the blame must be borne by the miners themselves.

This was a period when coal consumption, and hence the number of miners employed, was rapidly rising. There was no legislation to enforce the use of

the safety lamp and many miners did not like it because it did not give out as much light as a candle. A consequence was that in many cases where the lamp was enforced by the owners, the miners would remove the gauze to get a better light.

This problem was overcome by providing the lamps with locks. Later other improvements came along such as putting a cylinder of safety glass around the flame to improve the illumination, and covering the gauze by a metal bonnet to protect it from accidental damage. The flame safety lamps in use today are all based on Sir Humphrey Davy's principle.

Every time an official or workman uses it to test for gas he is putting his faith in that unpatented discovery of 1815. *Irvin Saxton*
Pontefract,
West Yorkshire

Natural polonium

John Urquhart's article "Polonium: Widescale's most lethal legacy" (31 March, p 883) must have given many of its readers the impression that polonium is an abnormal constituent of man's environment and with an impact that is therefore unpredictable.

In fact it has been known since the late 1950s (see for example *Nature*, vol 208, p 423) that ²¹⁰Po is widely distributed in the environment, and in man, as a result of atmospheric fall-out of the decay products of natural radon-222, with an abundance in northern temperate latitudes of about 0.06 curie per sq km or of the order of 10⁶ curies in total over the surface of the world land mass.

In this connection considerable thought has been given to the nature and magnitude of the resulting biologically effective radiation dose to the general population. The United Nations Scientific Committee estimates this as 130 uSv (13 mrem) per

year, or 6.5 per cent of the total normal natural background dose rate. It is in this context that the estimated release of 370 curies of ²¹⁰Po from Windscale should be viewed.

C. R. Hill
Institute of Cancer Research
Sutton, Surrey

Meteorite showers

N. W. Pirie casts doubts on the figure of 100 000 meteorites having fallen in a shower in Poland in 1868 (*Letters*, 31 March, p 914). The British Museum (*Natural History Catalogue of Meteorites*, third edition (1966) mentions a piece in *Nature* (vol 140, p 113) by E. Stenz, who thought that 3000 was more likely for the Pulask meteorite shower.

However, in the same journal (vol 140, pp 504, and 809) the meteoriticist F. A. Paneth mentioned the higher value. B. Lang and M. Kowalski (*Meteorites*, vol 6, p 149) estimated 180 000 in 1971. *Geraint Davy*
Swindon, Wiltshire

Any bright sparks?

I have come upon one or two cases of people who have acute sensitivity to electricity and to electrical devices, such as television sets, computers, radios, electric lights, etc. I would be very interested to hear from any readers who experience this effect, or who find even the presence of electricity disturbing.

Any reports that readers send me will be treated with complete confidentiality.

Michael Shalish
Rewley House
3-7 Wellington Square
Oxford

We welcome letters from our readers. Short communications stand the best chance of publication. We reserve the right to edit the longer ones. Write to: *Letters to the Editor, New Scientist, Commonwealth House, 1-19 New Oxford St, London WC1A 1NG.*

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Drake Circus, Plymouth, Devon. PL4 8AA



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Experience of using Basic programming language on micro computers and Hewlett Packard desktop computers, and any experience on HP mini-computers, would be an advantage.

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If it fits in with your own career plans please write or telephone for an application form to: Miss Katie Smith, Personnel Officer, Avon Cosmetics Limited, Nunn Mills Road, Northampton NN1 5PA (0604) 34722 ext 382.

AVON

WESSEX REGIONAL IMMUNOLOGY SERVICE, TENOVUS LABORATORY, SOUTHAMPTON GENERAL HOSPITAL

Senior Scientific Officer

(Salary scale £9010-£11 649). Applications are invited from science graduates with a higher degree for this NHS funded permanent position. The laboratory provides immunoassay services and acts as a reference centre for the Southampton District and Wessex Regions. The successful applicant will be responsible principally for the production and evaluation of monoclonal and polyclonal antibodies for diagnosis and research use. The unit has a strong research interest in lymphocytic disease and the applicant will be expected to join current research programmes.

Scientific Officer

(Salary scale £6277-£7471). Applications are invited from science graduates for this NHS permanent position. The laboratory provides immunoassay services and acts as a reference centre for the Southampton District and Wessex Regions. The successful applicant will be involved primarily in the preparation and standardisation of polyclonal and monoclonal antibodies for diagnostic use. The department has a strong interest in lymphocytic disease and research activities are encouraged. Closing date for the post is 31 May 1983.

Job descriptions and application forms for both posts available from Dr J. L. Smith, Regional Immunology Laboratory, Southampton General Hospital, Tenovus Road, Southampton Telephone (0703) 771222 Ext 3490.

UNIVERSITY OF GLASGOW DEPARTMENT OF ELECTRONICS AND ELECTRICAL ENGINEERING I.T. LECTURESHIP AND RESEARCH ASSISTANTSHIP IN INTEGRATED OPTICS AND OPTOELECTRONICS

The Department has been allocated one of the 30 nationally awarded academic appointments, to strengthen research in integrated optics and optoelectronics and contribute to the teaching work of the Department. Appointment will be to a Lectureship to supplement the work of a large group conducting research in integrated optics, optical signal processing, optical communications and optical sensors, with complementary research on high resolution E-beam lithography and growth of III-V semiconductors by MBE.

Salary will be within the range £8375-£13 505 on the Lecturers' scale (under review), with placement according to age, qualifications and experience. Further particulars may be obtained from the Secretary of the University Court, Room 118, University of Glasgow G12 8QD, with whom applications (eight copies), giving the names of three referees, should be lodged on or before 20 May 1983. In reply please quote Ref No 4980.

The Research Assistantship is made available by a new SERC grant for three years; appointment will be on the RAS 1A scale at a commencing salary up to £9370 (under review). Relevant experience in areas such as physical optics, materials science, micro-wave or communication systems is desirable. Applications (two copies), giving the names of two referees, and requests for further details should be sent to Professor John Lamb at the above address, before 20 May 1983.

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Experience as a Medical Representative is the best possible foundation for a career in Marketing or Sales Management. Many of today's Marketing Directors started this way.

You will see the business from the sharp end, detailing clinical pharmaceuticals to hospital doctors and GPs. It's a demanding sales job in a competitive environment, but both the experience and rewards will be

outstanding.

If you're a confident, articulate Life Sciences graduate aged under 30 looking for a challenging role with long term development prospects, we'd like to hear from you.

Contact us today for a Personal History File.
Sutcliffe Selection, Hope House, 46-48 Essex Road, Basingstoke, Hants, GU24 5PPS (24 hours).

Sutcliffe Selection

THE UNIVERSITY OF ASTON IN BIRMINGHAM Aston Microprocessor Unit COMPUTER OFFICER

Applications are invited for the post of Computer Officer in the Microprocessor Unit. The Unit has well-equipped laboratories for teaching and research, and the equipment base spans the range from minicomputers to industrial-standard microprocessors. The main operating system is UNIX, although a wide variety of processor operating systems is used in the laboratory. A network of modern 16-bit processors is used to provide the main teaching environment.

The post carries responsibility for systems software, the programming support environment and applications programs. The successful applicant will be expected to participate in design work and to provide specialist advice to staff and students. The post should offer a first-class opportunity to those wishing to gain experience of modern software engineering.

Candidates should have a good honours degree or postgraduate qualification in software engineering, and experience of systems programming or real-time programming. Knowledge of UNIX, and of assembler-level programming would be a definite advantage.

Salary within the Other Related IA Scale £6375 to £11 105 ps.

The post is initially for a fixed term until 31 December, 1985.

Applications forms and further particulars available from Mr A. G. Rees, Staffing Dept, University of Aston in Birmingham, Costa Green, Birmingham B4 7ET (021-359-3611) quoting Reference No 83/23/NS.

UNIVERSITY OF LEICESTER Department of Physics LECTURESHIP IN X-RAY ASTRONOMY

Applications are invited for a newly created post of Lecturer in the Department of Physics, to commence from 1 October, 1983. The successful applicant, who should normally be aged less than 35, will be attached to the X-ray Astronomy Group. Preference will be given to persons with specific experience in experimental astrophysics or high energy particle or radiation physics.

Initial salary will depend upon qualifications and experience on the Lecturers' Scale £375 to £13 505.

Further particulars from the Registrar, University of Leicester, University Road, Leicester LE1 7RH. To whom applications should be sent on the form provided by 31 May, 1983.

UNIVERSITY OF YORK

Department of Physics "NEW BLOOD" LECTURESHIP

Applications are invited for a "New Blood" Lectureship from candidates with research interests in the area of direct methods in crystallography and/or techniques for resolving macro-molecular structures.

Salary on the Lecturers' scale, £6375-£13 505, with USS. Applicants should be less than 35 years old on 1 October, 1983.

Six copies of applications (one only from overseas candidates), naming three referees, should be sent by Monday, 9 May, 1983, to Acting Registrar, University of York, Heslington, York YO1 5DD, from whom further particulars may be obtained. Please quote reference number 12/3195.

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research**

Packaging Materials Specialist

We require an experienced Packaging Materials Specialist as a member of our Frozen Products Packaging Research team. The job holder will be based at Colworth and will have a central and responsible role within the Packaging Group, as an adviser on technical matters. He/she will have daily contacts with research scientists and will be closely involved with the Unilever Companies' Packaging Managers on various development projects.

In addition, he/she will be given direct responsibility for specific research projects relating to packaging.

The successful applicant will ideally be aged under 35, will possess an honours degree in a scientific discipline, and will have **proven experience in the packaging area**, preferably in industry.

Starting salary will be in our normal range for research scientists and will be commensurate with qualifications and experience, ranging from £10,000-£12,000. The remuneration package includes car allowance, contributory pension scheme, private medical insurance and five weeks holiday. Assistance with relocation expenses will be given where appropriate.

Colworth is the largest and most modern centre for food research in Europe, with a staff of 1300. It is situated in a pleasant country estate, 10 miles north of Bedford.

Please write for an application form and further details, quoting reference CH278M, to:

Mr. Peter Thomas,
Recruitment Manager,
Unilever Research,
Colworth Laboratory,
Sharnbrook,
Bedford MK44 1LQ.



NEWCASTLE UPON TYNE POLYTECHNIC

Faculty of Engineering

APPOINTMENT OF TEACHING ASSOCIATES

(Two posts, to be based at Annan, Scotland)

Ref No EXF6/83

Applications are invited for two-year appointments as Teaching Company Associates to a joint SERC and Department of Industry programme with NEI Cochran Limited. The posts offer excellent opportunities to develop technological and managerial skills. Specialist updating courses will be provided where necessary at the Polytechnic and elsewhere, and successful applicants will have the opportunity to register for a higher degree.

The vacancies are for work in the following areas:

(1) to investigate changes and review previous systems in, and plan the integration of, manufacturing requirements and technologies in the construction of packaged boilers.

Each Associate will be responsible for one of the projects. Applicants should possess a good honours degree in an appropriate branch of engineering or science. Previous industrial experience is desirable.

Appointments will be made at salary points on the Researcher "A" or "B" scales, depending on qualifications.

Salary Scale Researcher Scale "A" £5355-£6039 p.a.

Researcher Scale "B" £6655-£9330 p.a.

Applicants wishing to discuss the project should contact Professor K. N. Strafford, (0632) 326002 ext 330.

For further details and application form, please call our 24 hour telephone answering service (0632) 323126 or send a stamped addressed envelope to Mrs Rosemary Smith, Administrative Assistant (Recruitment), Ellison Building, Ellison Place, Newcastle upon Tyne NE1 6ST, to whom completed applications should be returned, quoting the reference number and stating which project you wish to apply for, by 13 May 1983.

Systems Development Programming

Swindon, Wilts up to £9126

The Natural Environment Research Council (NERC) Computing Service provides a complete range of computing facilities for scientific research in the Earth Sciences (Geology, Oceanography etc.)

We are exploiting the technological advances in mini and micro computer systems in order to provide our scientists with increasingly more sophisticated facilities for scientific data collection and experiment control as well as general purpose computing.

At our central development laboratory in Swindon, we are engaged in micro and minicomputer systems and networking developments. The systems in use include GEC, PDP/LSI 1, PERQ, Apples, Cifer and Intel together with a number of languages including C, Pascal and Assembler. Given that range of hardware and software, we need people who are flexible and sufficiently self motivated to solve the enormous variety of problems.

Swindon is an ideal centre for many activities, and is close to the Cotswolds and the Marlborough downs. It also has excellent rail and motorway links to London and the West Country.

Whilst the NERC is not a Government Department, conditions of service are similar to those of the Civil Service. Starting salary will depend on age, qualifications and experience and will be in the range £5422 - £7399 (Scientific Officer) or £6840 - £9126 (Higher Scientific Officer). If you have a degree or equivalent together with some relevant experience, write or telephone for further information and an application form to:

C.I. Brohier, NERC Computing Service, Holbrook House, Station Road, Swindon, Tel: Swindon (0793) 40101 Ext 523.

Completed application forms should be returned by 6th May 1983.

Natural Environment Research Council

Hurst PLANT BREEDER/AGRONOMIST

There will be a vacancy for a Plant Breeder/Agronomist to work on novel protein and oilseed crops at the Hurst Crop Research and Development Unit from 1st July 1983.

Applicants should have a degree and at least two years relevant post-graduate experience.

Further details and application forms are available from:

Mrs. Sylvia Hunt,
Hurst Crop Research and Development Unit,
St. Demas Farm,
Feering, Colchester, Essex. CO5 9ES.
Tel: Kaverdon (0378) 71123.
HURST CROP RESEARCH AND DEVELOPMENT LTD.
An Agricultural Holdings Seeds Division Company



Cytogeneticist

Applications are invited for the post of Cytogeneticist with Sterling-Winthrop Research and Development in our new, purpose-built Research Centre situated in a rural parkland setting in Alnwick, Northumberland.

Duties will involve studying the effects of new chemicals/drug entities on chromosomal structure including the micronucleus test and metaphase analysis of cultured mammalian cells. Active participation in the development of new techniques is also envisaged.

Candidates should have either a degree in the biological/biochemical field with significant postgraduate experience in Cytogenetics or a sound technical training with at least three years experience in this area.

This position offers an attractive salary and the usual benefits associated with a major company plus the opportunity of working in a particularly attractive environment.

To apply, please write to:

The Personnel Manager, Sterling-Winthrop Research and Development, Alnwick, Northumberland, NE66 2JH.



ENVIRONMENTAL SCIENCES UNIT RESEARCH OFFICER

Applications are invited for a Research Officer to assist in an interdisciplinary programme of work to study the feasibility of creating a heritage zone at Clonsilla, Co. Offaly. The study will focus on a raised bog and its relationship to the monastic site and surrounding landscape. Applicants should have qualifications and experience in at least one of the following areas and be prepared to undertake supervised work on the others: plant ecology, terrestrial geomorphology or hydrology. The Research Officer will be expected to spend a substantial amount of time in field-work.

This post is tenable immediately and the project terminates in September, 1984. Salary, subject to qualifications IR£5000-£6400 p.a.

Application forms and further details may be obtained from: **Establishment Officer, Staff Office, Trinity College, Dublin 2**

The closing date for receipt of applications will be Friday 6 May 1983

ST MARY'S HOSPITAL MEDICAL SCHOOL (University of London) Norfolk Place, London W2 1PG JUNIOR B MEDICAL LABORATORY SCIENTIFIC OFFICER

required in Medical Unit for initial one year period. Applicants must have two Science 'A' Levels including Chemistry.

Salary £4322 p.a. inc.

Apply in writing with full cv and name and address of school or work based referees to St Mary's Hospital Medical School, Norfolk Place, London W2 1PG by 6 May.

Portsmouth and South East Hampshire Health Authority

PHARMACY TECHNICIAN Quality Control

Working in a well equipped laboratory at Queen Alexandra Hospital. Duties involve working on a wide range of pharmaceutical and other products. This post offers an opportunity to obtain extensive experience in analytical and microbiological techniques and to participate in several Regional services. Applicants should have a minimum of 2 science 'A' levels or TEC ONC or equivalent. Previous laboratory experience preferable. Applicants should also be qualified drivers. Salary £4283.

Application form and job description from Personnel Officer, Queen Alexandra Hospital, Cosham, Portsmouth PO6 3LY.

NORTH EAST THAMES REGION IMMUNOASSAY UNIT Associated with the Department of Chemical Pathology at St Bartholomew's Hospital.

BIOCHEMIST

required to work in a unit specialising in radioimmunoassay and its application to Clinical Chemistry and Endocrinology. Previous experience not essential.

Salary Scale: £8678-£9346 p.a. inclusive (depending on qualifications and relevant experience). For further details about the post contact Dr R. Edwards on 01-606 2113.

Application forms available from the Personnel Department, St Bartholomew's Hospital, London EC1 or telephone 01-600 9600, ext 3188, quoting Ref. TG/72.

UNIVERSITY OF LIVERPOOL Radiation Oncology, Clatterbridge Hospital, Wirral TECHNICIAN (GRADE 3)

New post in an expanding research team interested in the production of monoclonal antibodies directed against human tumour associated antigens. Duties involve participation in experimental research but also a significant degree of routine preparatory work. Experience of tissue culture and immuno-logical understanding preferable but not essential. ONC or appropriate equivalent is minimum acceptable qualification plus three years laboratory experience.

Salary in range £4929-£5775 p.a. Application forms may be obtained from the Registrar, The University, PO Box 141, Liverpool L69 3BX. Ref: RV/916.

THE MATHILDA AND TERENCE KENNEDY INSTITUTE OF RHEUMATOLOGY COMPUTER SCIENTIST

The Kennedy Institute is in the forefront of research into rheumatic diseases and is making its first approaches into the general use of computers. A new post has been created for the development of computing in the Institute and the person appointed will be responsible for selection of the equipment and its introduction and use.

Applicants should have at least five years' experience of computing in the biological or medical area, have an interest in computing in biological research and be capable of making their own technological decisions. The post is a challenging one and will require someone with initiative and with the ability to liaise successfully with scientists involved in biological research.

The salary is on Range 1A of Research and Analogous Staff scales. (£7225-£11166 plus London Weighting £1158). Applications including full curriculum vitae and the names of two referees should be sent to the General Secretary, The Mathilda and Terence Kennedy Institute of Rheumatology, 6 Bute Gardens, Hammersmith, London W6 7DW. Closing date 16 May, 1983.

Graduate Scientists & Technologists

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Scientific Staff Consultants, 58 Lincoln's Inn Fields, London WC2



UNIVERSITY OF EAST ANGLIA Norwich

LECTURER IN OCEANIC AND ATMOSPHERIC SCIENCES

Applications are invited for this lectureship in the School of Environmental Sciences which is available from 1 October, 1983, under the UGC's "New Blood" scheme. The primary role of the lecturer in the first year will be to contribute substantially to research. Salary on the scale £6,375-£11,505 per annum (under review) plus US\$ benefits.

Applicants should have recent experience of some aspects of the role of the oceans in the CO₂/climate problem, and be familiar with ocean circulation and climate modelling techniques.

Applications (three copies), giving names of three persons to whom reference may be made, should be lodged with the Establishment Officer, University of East Anglia, Norwich, NR4 7TJ, from whom further particulars may be obtained, not later than 14 May, 1983. No forms of application are issued.

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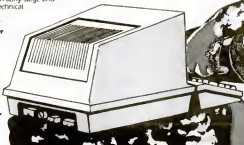
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This combination of variety, training and Scicon's progressive approach ensures a challenging environment, real responsibility at an early stage and opportunities to move into Senior Technical Consultancy or Management.

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From an original sculpture by Rodin

UNIVERSITY OF LEICESTER

Department of Physics LECTURESHIP IN CONDENSED MATTER PHYSICS

Applications are invited for a Lectureship in the Department of Physics tenable from 1 October, 1983. Applicants, who must normally be under 35, should have research interests in experimental condensed matter physics. Preference will be given to persons who have specific experience with the techniques of photoemission or time-resolved spectroscopy, and who have worked or have interests in the fields of amorphous semiconductors, surfaces or interfaces.

Initial salary will depend on qualifications and experience on the Lecturers' scale £6375 to £13 505.

Further particulars from the Registrar, University of Leicester, University Road, Leicester LE1 7RH, to whom applications should be sent on the form provided by 31 May, 1983.

BIOLOGY GRADUATE

A graduate is required to undertake a project testing a novel insecticide against resistant strains of house fly. Applicants should be competent to run a laboratory project, which will last for six months and be carried out in collaboration with the Ministry of Agriculture.

Apply to: Mr D. Picken,
 Ciba-Geigy Agrochemicals,
 Whiteford,
 Chertsey,
 Surrey, GU21 2AT.
 Tel. Chertsey (0223) 833621

BRITISH ANTARCTIC SURVEY

Terrestrial Biology Assistant

A BIOLOGICAL ASSISTANT is required to provide technical support for terrestrial studies at Signy Island, South Orkney Islands. The duties will involve assistance with field and laboratory research work throughout the year in various terrestrial projects, which will include microclimate monitoring, invertebrate ecology and physiology, plant biology and microbiology. In addition, the maintenance of long-term study sites, the deployment and servicing of a variety of field instruments, the care of field huts, supervision of the biological stores and insects are integral parts of the work. Since some of the research sites are remote from the station, much cross country walking will be involved. It should be noted that such work will not normally lead to a higher grade.

The post is a period appointment of approximately 33 months commencing in September 1983 and the successful candidate will have a short training period at the Survey's laboratories in Cambridge prior to sailing for the Antarctic in mid-October 1983.

Qualifications: HNC/HND/AIST/City & Guilds Advanced Certificate/first degree in biology, botany or zoology, biological sciences. Technical experience is highly desirable and some knowledge of invertebrate, botanical or microbiological research techniques would be advantageous.

Applicants to work mainly overseas, must be physically fit, single male aged 22-35.

Salary: £5709-£6665 per annum plus a supplement of £586 per annum payable for periods of service spent south of Montevideo. Low income tax. Clothing, messing and canteen provided free on base and free messing on voyage.

For further details and an application form, please write to:

The Establishment Officer British Antarctic Survey,
 High Cross, Madingley Road, Cambridge CB3 0ET.

Please quote ref: LS 9/83
 Closing date: 12 May 1983.

NATURAL ENVIRONMENT RESEARCH COUNCIL

UNIVERSITY OF NOTTINGHAM

Department of Geography
 Applicants are invited for a
 LECTURESHIP

established under the national scheme to encourage the appointment of younger members of the academic staff (the "New Blood" scheme) and tenable in this Department. Candidates for this appointment with particular reference to Remote Sensing of the Environment should have experience in one or more areas of Remote Sensing. Special consideration will be given to applicants with experience of digital methods.

Applicants should normally be under the age of 35 years and salary will be within the range £6375-£13 505.

Further particulars and application forms, returnable not later than 9 May, 1983, should be obtained from the Staff Appointments Officer, University of Nottingham, University Park, Nottingham NG7 2RD. Ref no 660.

ST BARTHOLOMEWS HOSPITAL, LONDON EC1A 7BE

Department of Immunology
 MEDICAL LABORATORY
 SCIENTIFIC OFFICER OR
 JUNIOR B.M.S.O.

Applications are invited for the post in a busy routine Immunology department.

Salary £4453-£8744 pa inclusive (depending on age and qualifications).

For further information and/or to arrange a visit to the department please ring Mr J. W. Miller, Senior Chief M.L.S.O. Tel 01-600 9000 ext 2945.

Application forms available from the Personnel Department on ext 3188. Please quote ref TG/71.

UNIVERSITY OF LONDON
Royal Postgraduate Medical School
 (Department of Histopathology)
LECTURER IN
HISTOCHEMISTRY

Applications are invited for the above non-clinical post which is available with immediate effect. The post has been established for a fixed term of three years to facilitate the development of a series of eight annual one week short courses in advanced laboratory techniques. It will be the primary responsibility of the successful candidate to organise the courses and to teach on them. In order to discharge these responsibilities the successful candidate will be required to engage in a programme of research from which the syllabus of the courses will develop.

Candidates should be good teachers with experience in immunocytochemistry and electron-microscopy.

Salary on the scale for non-clinical lecturers. It is envisaged that an appointment will be made on the lower half of the scale.

Candidates should apply by letter, enclosing six copies of their curriculum vitae, a statement of not more than 500 words on why they are applying for this post, and naming three referees to: The Deputy Secretary, Royal Postgraduate Medical School, Hammersmith Hospital, Du Cane Road, London W12 0HS, from whom further particulars may be obtained. Applicants who wish to discuss the post may do so by contacting Dr John M. Polak (01-743 2030, ext 355).

Closing date for applications: 31 May, 1983.

UNIVERSITY OF LEICESTER
Department of Chemistry
A LECTURESHIP IN
BIOLOGICAL CHEMISTRY

Has been established under the New Blood scheme in order to strengthen the collaboration within the University between chemistry and molecular biology. The post is tenable from 1 October, 1983. Applications are invited from organic chemists with post-doctoral experience and achievement in biochemical or molecular biology who wish to establish a research programme in biological chemistry.

Initial salary will depend on qualifications and experience on the Lecturers scale £6375 to £13 505. Further particulars from the Registrar, University of Leicester, University Road, Leicester, LE1 7RH, to whom applications should be sent on the form provided by 31 May, 1983. Informal enquiries can be made to Professor S. Trappett, Department of Chemistry.

THE KENNEDY INSTITUTE OF
RHEUMATOLOGY
RESEARCH ASSISTANT

A recent graduate is required for a position as a research assistant in the Division of Cellular Biology. The work involves the use of highly sensitive cytochemical bioassay of parathyroid hormone to assay this hormone in various rheumatological disorders and is funded for three years.

Starting salary is up to £7533 inclusive of London Weighting on Range 1 of the scale for Research and Analogous Staff.

Applications with full curriculum vitae and the names of two referees should be sent to: The General Secretary, The Kennedy Institute of Rheumatology, 8 Bute Gardens, Hammersmith, London W8 7DW.



Millipore (UK) Limited

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You will liaise closely with research, development, production and quality control departments within the pharmaceutical, biotechnology, food and beverage industries and with government biological research establishments, to advise on the optimum use of Millipore products to meet customer needs. Applications include sterilizing and clarifying filtration of liquids and gases, water purification, ultrafiltration and other processing of biological products.

The position will suit graduates under 28 years of age with a degree in a Biological Science, who wish to develop a commercial career whilst making full use of their scientific education. A minimum of two years' work experience is necessary, and sales experience, though not essential, may be an advantage. The successful applicant will have a positive outgoing personality and be a fluent communicator. Travel throughout the UK will be required with some travel within Europe and possibly the U.S.

Remuneration will be negotiable around £10,000, dependent on experience. An executive 2 litre car and the usual benefits will be provided. For initial application either telephone our consultant Graham Langley, or write to him enclosing a full c.v. quoting Ref. 736.

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 Telephone: 01-839 2445 (24 Hr.)

UNIVERSITY OF LIVERPOOL
"NEW BLOOD"
LECTURESHIP IN ORGANIC
CHEMISTRY

Applications are invited for a post of Lecturer in the Department of Organic Chemistry, established under the UGC "New Blood" initiative and tenable from 1 October, 1983. Candidates should normally be aged 35 or under on appointment, but preference will be given to candidates below the age of 30.

The successful candidate will be expected to undertake some teaching but the major commitment will be research into the synthesis of natural products; for this reason some research experience in this area is essential. Candidates should hold a PhD degree and some research experience at the post-doctoral level is desirable.

The initial salary will be at the appropriate point within a specified range on the Lecturers scale (£6375-£13 505 pa).

Applications, together with the names of three referees, should be received not later than 30 June, 1983, by The Registrar, University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref. RV/917.

UNIVERSITY OF NOTTINGHAM
School of Agriculture
Department of Agriculture and Horticulture

Applications are invited for a
POST DOCTORAL RESEARCH
FELLOW

to work on a MAPP funded project investigating the efficacy of plant growth regulators in winter cereals. The proposed research will involve monitoring field scale trials in which plant growth regulators have been applied to winter cereals. The person appointed will be expected to co-ordinate trials at two centres and manage the day-to-day running of the project. The objective of the study will be to achieve a better understanding of those factors which control the efficacy of plant growth regulators in crops of winter cereals.

The post will be available from 1 June 1983 for three years. The commencing salary will be £6880.

Applications giving qualifications and experience, together with the names of two referees should be sent by 9 May 1983 to: Dr T. C. K. Dawkins, Dept. of Agriculture and Horticulture, University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, Leics LE12 5RD.

NOTTINGHAM HEALTH
AUTHORITY

University Hospital
MEDICAL LABORATORY
SCIENTIFIC OFFICER

The Immunology department is responsible for teaching and research within the Medical School in addition to providing a comprehensive clinical immunology service to the Nottingham area. Candidates with an HNC (BSc), appropriate HND or biological sciences degree will be considered. Previous experience in Immunology is desirable but not essential and the successful applicant will be able to acquire experience with a variety of immunological techniques. An approved course for the Special examination in immunology for the FIMLS is established at the Trent Polytechnic. Salary scale: MLESO £3481 pa, rising by annual increments to £7747 pa. Junior "B" scale £6674 (age 21) to £4818 pa. Further details may be obtained from Mr A. D. W. Marriott, Senior Chief MLESO, Immunology Department, tel (0602) 700111 ext 352. Application forms from Miss J. Pacer, Unit Personnel, Queen's Medical Centre, University Hospital, Nottingham ext 3781. Closing date 14 May, 1983.

UNIVERSITY OF LIVERPOOL

"New Blood"
LECTURESHIP IN
PURE MATHEMATICS

Applications are invited for the post of Lecturer in the Department of Pure Mathematics, established under the UGC "New Blood" initiative and tenable from 1 October, 1983. Candidates should normally be aged 35 or under on appointment.

Preference will be given to candidates whose research lies on one of the following areas: Fourier integral operators, microlocal analysis, analysis of Kleinian groups, or any area of analysis having close links with some branch of topology or geometry.

The initial salary will be at an appropriate point within a specified range on the Lecturers scale (£6375-£13 505 pa).

Applications, together with the names of three referees, should be received not later than 6 May, 1983, by The Registrar, University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref. RV/918.

NATIONAL INSTITUTE FOR
BIOLOGICAL STANDARDS AND
CONTROL
SCIENTIST—
CHEMISTRY SECTION

This post has been created to strengthen existing resources for work on proteins and polypeptides. It will be concerned particularly with the development and application of analytical and sequencing techniques to the study of therapeutic interest (hormones, blood products, viral proteins).

Applicants should have a PhD and post-doctoral experience in a relevant area of chemistry or biochemistry. This post could lead to a permanent appointment.

Starting salary will be dependent on experience, qualifications and age. The initial salary scale is £240 plus £1158 London Weighting.

For further details and an application form please contact the Personnel Officer, NIBSC, Holly Hill, Queens Road, Colindale, London NW9 0HT. Tel: 01-435 2232. Please quote reference number CH/156. Closing date 20 May, 1983.

As one of the largest suppliers of ethical pharmaceuticals to the NHS the Merck Sharp & Dohme name and product range are obviously already familiar throughout the medical world, and it is the task of our two Medical Information Officers to ensure that this awareness is maintained.

Based at UK Head Office, working in close association with our Medical Advisers, they are responsible therefore, for answering enquiries from the medical profession, pharmacists and our own sales force; for monitoring information from authoritative sources worldwide; and for creating from it a

medical data system for the consultation of MSD staff.

To become a member of this team, you will need to be a science graduate, ideally with an M.Sc. in Medical Information and some experience in an environment and a role of this kind. Full induction and product training will naturally be given and you will be encouraged to attend regularly - courses, conferences and symposia to broaden and consolidate your expertise.

The Merck Sharp & Dohme salary and benefits package is also highly attractive. It includes expenses for relocation, where required, to this pleasant, rural area of Hertfordshire.

Please contact Lyn Bennington, Personnel Officer, Merck Sharp & Dohme Limited, Hertford Road, Hoddesdon, Hertfordshire. Telephone: Hoddesdon 467272.

Medical Information Officer

MERCK
SHARP
DOHME



Scientist/Engineer - Gas Utilisation

SW LONDON up to £12,779

The Watson House Research Station in Fulham has a vacancy in a multi-disciplinary team working on the combustion characteristics and interchangeability of natural and substitute natural gases (SNG), as related to domestic gas utilisation.

Work includes the assessment of appliance combustion performance as a function of gas composition. Occasionally the work involves visits to gas production sites and therefore applicants should be willing to travel.

Applicants should hold a degree or equivalent in a relevant scientific or engineering discipline and preferably have some industrial experience.

The appointment will be made in the range £7,084 to £11,801 inclusive of Inner London Weighting, (or possibly higher to £12,779) depending on experience and qualifications. Benefits are those normally associated with a large progressive organisation.

Write for application form to: Personnel Officer (Fulham), British Gas, Watson House, Peterborough Road, London SW6 3HN, quoting reference WH/314/NS, or phone Mrs. White on 01-7361212 ext. 3358 during business hours.

BRITISH GAS

Statistician

Wembley Park

Roussel Laboratories Limited, part of an international group, research, manufacture and market a range of ethical pharmaceutical products in the UK and throughout the world. Because of our increasing development of new products, we need someone to assist the head of our Statistical Unit with the statistical organisation and analysis of clinical trials. The work will involve close liaison with our team of medical advisers and clinical research staff.

The ideal candidate will have a first degree in statistics, and about two years' experience in the pharmaceutical industry. The ability to make use of standard computing tools is essential.

In addition to an excellent salary, we offer free medical, life and sickness insurance, and a free staff restaurant.

For an application form, please contact Mrs Elizabeth Bedford, Roussel Laboratories Limited, Roussel House, Wembley Park, Middlesex HA9 0NF. Telephone: 01-903 1454.

ROUSSEL



The Water Research Centre has three main laboratories, one at Medmenham, Bucks, the second at Slievevea, Herts and the third newly constructed at Swindon, Wilt. WRC, with a total staff of 500, is the national centre for water research in the United Kingdom and is one of the largest water research organisations in the world. It is financed principally by the Regional Water Authorities, the Water Undertakings and the Department of the Environment.

Hydrogeologist

A hydrogeologist is required to work within the Aquifer Pollution Section from the WRC's Medmenham Laboratory, near Marlow, Bucks. The successful applicant will be required to take part in both research studies concerning contamination of groundwaters, and in short-term commercial operations work. Much of the work will involve travel within the United Kingdom and a current driving licence is essential. The successful applicant may also be required to undertake short overseas postings.

Applicants should possess a good degree in earth sciences, preferably with some post graduate experience in hydrogeology. Salary will be in the range £6,444 to £8,553 p.a. depending on age, qualifications and experience.

Please write for an application form, to be returned by 6 May, quoting post no. 52, to the Personnel Department, Water Research Centre, PO Box 16, Henley Road, Medmenham, Marlow, Bucks, SL7 2HD.



THE OPEN UNIVERSITY

Faculty of Science EARTH SCIENCE TECHNICIAN

The Science faculty has a vacancy for a technician in the Earth Sciences discipline.

The main duties of the post are to extract oxygen, hydrogen and carbon dioxide from rock samples and to assist in analysing these gases in the gas-source mass spectrometer (SIRA 24). Data obtained from such techniques contributes to the department's strong geological research programs. An interest in instrumental analytical techniques applied in a research environment is essential.

Applicants should have technical experience and should possess City & Guilds (Adv) or HNC in relevant subjects. Some years experience with high-vacuum technology is required. Salary will be in the technician grade VI scale (£6890-£8232 per annum).

Application forms and further particulars are available from Dr J. W. R. Smith (MS70/1), Administrative Assistant, (Science) Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA or telephone Milton Keynes (0908) 653009; there is a 24 hour answering service on 653686.

Closing date for applications: 27 May.

MEDICAL REP JOB CENTRE

Selling prescription medicines is a professional career where your science qualification is respected and financial rewards are considerable.

Vacancies exist throughout the UK

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AEROSPACE DEFENCE COMMUNICATIONS AEROSPACE

SYSTEMS ENGINEERS

To formulate a total systems concept be it for AVIONICS, GUIDED WEAPONS, SONAR, RADAR, COMMUNICATIONS, SATELLITES, CONTROL, GUIDANCE requires a first class analytical approach with a knowledge of Mathematical Modelling, Real Time Programming, Assessment Studies, Operation Research and an aptitude for "seeing the wood for the trees".

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AEROSPACE DEFENCE COMMUNICATIONS AEROSPACE

UNIVERSITY OF ST ANDREWS DEPARTMENT OF PHYSICS

Lectureship in Applicable Optics

Applications are invited for a post of LECTURER for appointment from 1 October, 1983. This is a permanent post which has become available as a result of an award by the UGC under its "New Blood" scheme. The upper age limit will be 35. The successful candidate will be expected to conduct research in all areas of optics which extends the established research of the Department of Laser, Optoelectronics or Semiconductors and to contribute to the teaching of the postgraduate half of Joint Honours courses and to the taught MSc course on Optoelectronic and Laser Devices. Candidates should have an appropriate background in Solid State Physics, Laser Optics or Electronic Engineering.

Salary at appropriate point on scale £6775-£13505 per annum, plus USS, starting salary probably not above £9370 per annum.

Applications (two copies preferably in typewritten, with the names of three referees, should be sent by 14 May to the Establishment Officer, The University, College Gate, St Andrews, Fife, KY16 9AL, from whom further particulars are available.

THE UNIVERSITY OF LANCASTER

DEPARTMENT OF PHYSICS

Lecturer in Theoretical Low Temperature Physics "New Blood" Appointment

Applications are sought for a Lecturer in Physics whose research interests lie in the area of Theoretical Low Temperature condensed matter physics. The aim of the appointment is to give direct support to the experimental programmes carried out in the department, so that a research background in the general area of superfluids is desirable. The appointment will be on the Lecturer scale (£6357-£13505) from 1 October 1983.

Further particulars may be obtained (quoting reference L247/83) from the Establishment Officer, University House, Bailrigg, Lancaster LA1 4YW, to whom applications (two copies), naming three referees, should be sent NOT LATER THAN 20 MAY 1983.

THE UNIVERSITY OF SHEFFIELD

LECTURESHIP IN CHEMISTRY

Applications from candidates under 35 years old are invited for a new post in Inorganic Chemistry funded under the UGC's "new blood" scheme available from 1 October 1983. Candidates whose research interests lie in the investigation of organometallic reaction mechanisms, particularly by new analytical techniques, are especially encouraged to apply. Initial salary £6375-£13505 a year on the scale for Non-Clinical Lecturers. Particulars from the Registrar and Secretary (Staffing), The University, Sheffield S10 2TN to whom applications (five copies), including the names of three referees, should be sent by 23 May 1983. Quote ref: R87/H.

UNIVERSITY OF LIVERPOOL

Department of Medical Cell Biology

Applications are invited for the post of

POSTDOCTORAL SENIOR RESEARCH ASSISTANT

to work with Professor C. R. Hopkins on a project concerned with the intracellular processing of surface receptors. An interest in immunocytochemistry will be an advantage.

Salary within the range £6370-£7225 p.a.

Applications, together with the names of three referees, should be received not later than 6 May, 1983, by The Registrar, The University, PO Box 147, Liverpool L69 3GB, from whom further particulars may be obtained. Quote Ref: R9/916.

ST THOMAS'S HOSPITAL MEDICAL SCHOOL

Department of Immunology TWO RESEARCH ASSISTANT POSTS

Applications are invited for two posts of Research Assistant/Senior Research Technician to work on human interleukins and lymphocytes. Experience in immunology and cell culture highly desirable. Salary of both appointments in the range £9000-£10600 per annum including L.W. Appointments for one year in the first instance.

Applications including cv and the names of two referees should be sent to the Secretary, Department of Immunology, St Thomas's Hospital Medical School, London SE1 7EH.

UNIVERSITY OF ABERDEEN

Department of Biochemistry RESEARCH ASSISTANT

Applications are invited for the above MRC-supported research assistantship to work on a project entitled "Studies on cell death caused by some chemotherapeutic drugs". Under the supervision of Dr C. K. Pearson. The post is suitable for someone who is graduating this year with a good Honours degree in Biochemistry or appropriate discipline. The appointment is tenable for three years.

Commencing salary £5550 pa on the range IB scale for Research and Analogous.

Further particulars and application forms from The Secretary, The University, Aberdeen, with whom applications (two copies) should be lodged by 13 May, 1983.

Business Development Manager

Fine Chemicals Industry

Palmer Research Limited is a leading contract research and process development company specialising in organic chemistry for the pharmaceutical and fine chemicals industry. Internationally renowned for nearly two decades the company is undergoing a major expansion as a new member of the Johnson Matthey Group of Companies and seeks a business development manager to take charge of all aspects of selling and marketing.

The successful applicant will be a mature graduate in organic chemistry, preferably with a post-graduate qualification, and have considerable experience in selling and marketing specialty chemicals or related services on an international basis. An entrepreneurial outlook, a keenness to travel, and the drive and confidence to develop new sales opportunities for the company will be essential. Proficiency in French or German and a knowledge of information retrieval systems would be an advantage.

The senior appointment will command a competitive salary, a company car and the usual fringe benefits commensurate with such a position.

The company is located in a pleasant part of North Wales with convenient motor-way, rail and air links to the business centres of Europe.

Please write for interview, submitting a CV in support of your application, to:-

Dr. D. R. Palmer
Managing Director
PALMER RESEARCH LIMITED
Mostyn Road, Holywell, Clwyd
North Wales CH8 9DN
A Johnson Matthey Company



ADA/APSE

A major challenge in systems software design

£12,000-£18,000

Software Sciences are leading contributors to the implementation of the Ada compiler and its language support environment — APSE. This 4+ year programme is the major UK Ada development initiative, supported by several leading industrial organisations.

Systems software experts are now required to join the highly qualified project team. In-depth experience of environmental software is essential, with a sound knowledge of compilers and database management. Experience of high-level languages such as PASCAL or ALGOL 68 is also required, and some knowledge of Ada would be advantageous. We are also seeking Real-Time and Applications Programmer with high-level languages, for this and other projects.

Locations: Berkshire (just South of Reading), Macclesfield, Cheshire, and Farnborough, Hants.

Salaries: In all cases, highly competitive salaries will be supported by a full range of benefits, including relocation assistance where appropriate.

If you are interested in working on the development of Ada, which is likely to become a standard international language for both real-time embedded systems and for general purposes, then please write with full details to: Sharon McKeever, Software Sciences Limited, Abbey House, 282/292 Farnborough Road, Farnborough, Hampshire GU14 7NB. Telephone: 0252 544321.

SOFTWARE SCIENCES LIMITED



UNIVERSITY OF LONDON
British Postgraduate Medical Federation
THE CARDIOTHORACIC INSTITUTE
CARDIAC MUSCLE RESEARCH UNIT

TWO POSTS POST DOCTORAL RESEARCH ASSISTANT and RESEARCH TECHNICIAN

Applications are invited for the above posts which are available for 3 years for work on the biochemistry of protein turnover in the heart with Dr P. H. Sugden.

(a) For the post doctoral post, experience with amino acid analysis would be advantageous, though not essential. This post is on the University of London Research Assistant 1A grade with a starting salary not exceeding £7225 plus £1158 London weighting.

(b) For the technician post, a graduate or suitably experienced person will be preferred and there may be an opportunity to work for a higher qualification. This post is equivalent to the Whitley Council M50 grade with a starting salary not exceeding £5451 plus £593 London weighting.

Applicants to both posts will be required to contribute to the appropriate supervision scheme. Applications (with details telephone number, if possible), to the Institute Secretary, The Cardiothoracic Institute, Fulham Road, London SW3 6RF, to include two copies of full curriculum vitae and names, addresses and telephone numbers of two referees, reference to arrive no later than 31 May, 1983, quoting CM 92. Informal approaches to Dr Sugden (telephone 01-488 3043) welcomed.

NATIONAL BLOOD TRANSFUSION SERVICE (Wales)

SCIENTIFIC OFFICER

A science graduate (first or upper second class honours) is required to take part in the development of the second phase of computerisation at the Welsh Regional Blood Transfusion Centre. This will involve the blood donor records and collection session arrangements and will be linked to the complete laboratory system already developed. Some programming experience would be advantageous, but adaptability would be more important. Those expecting to graduate in 1983 are encouraged to apply.

The appointment is on the Scientific Officer scale (£6277-£8349) and will be for two years in the first instance with the possibility of re-appointment.

Whitley Council PTA terms and conditions of service.

Further particulars and application forms may be obtained from: Welsh Regional Blood Transfusion Centre, Rhydylafar, Cardiff CF5 6XF.

Closing date 31 May 1983.

THE UNIVERSITY OF SHEFFIELD

Department of Ceramics, Glasses and Polymers

POST-DOCTORAL RESEARCH ASSISTANT DEVELOPMENT OF A TUNABLE GLASS LASER

Applications are invited for the above post. The aim of the work is to develop a glass laser with a tuning range greater than is available from current dye laser systems. The research envisaged should be of interest to anyone with a background in physics, chemistry of materials science. Tenable for one year only from 1 September 1983 but strong possibility of extension. Salary in the range £6375-£7655 a year on Range 1A. Particulars may be obtained from Dr S. Parke, Department of Ceramics, Glasses and Polymers, Elmfild, Northumberland Road, Sheffield S10 2TZ to whom applications, including curriculum vitae and the names of two referees, should be sent as soon as possible.

Quote ref: R 814/74.

THE GRASSLAND RESEARCH INSTITUTE

Hurley, Maidenhead,
Berkshire SL6 6LR

STATISTICIAN

HIGHER SCIENTIFIC OFFICER/
SENIOR SCIENTIFIC OFFICER

required in the Statistics Section of the Biomathematics Division to act as a consultant to part of the Institute, providing advice on the design of experiments and the analysis and presentation of data.

Opportunities exist to collaborate fully in research projects and to initiate research into statistical methodology relevant to the Institute's research programme.

The work of the Institute is directed towards the efficiency of growth of grass and other forage crops and the effectiveness with which they are utilised in animal production. The Biomathematics Division, which has about 18 graduate and support staff, provides the computing, statistical and mathematical modelling expertise at the Institute.

Qualifications: first or upper second class honours degree in Statistics or Mathematics with Statistics or similar qualifications. At least two years relevant postgraduate experience is required for appointment to Higher Scientific Officer and four years for Senior Scientific Officer.

Salary: Higher Scientific Officer £6440-£9128
Senior Scientific Officer £8599-£10 987.

There is a non-contributory Superannuation Scheme.

Further particulars may be obtained from the Institute Secretary to whom applications together with a full curriculum vitae and the names of three referees should be sent by 20 May 1983 quoting 6/G/40.

UWIST

University of Wales

Applied Psychology Lecturer

'New Blood' appointment initially for applied research on human performance.

Areas of interest include problem solving under stress in hazardous industrial situations; cognitive skills, particularly process control, human error; memory; intelligibility of displays; artificial intelligence and simulation of industrial tasks. Age limit 35 years.

THE TOP POINTS OF THE SCALE ARE AVAILABLE FOR OUTSTANDING CANDIDATES

Salary: £6375-£13 505 per annum.

Requests (outing Ref. NS) for details and application form to Staffing Office, UWIST, PO Box 68, Cardiff CF1 3XA.

Closing Date: 13 May 1983

SCIENCE WRITER/EDITOR

For international conservation organisation to edit bulletins write articles and brochures.

Send CV to the IUCN Director General, World Conservation Centre, Avenue du Mont-Blanc, 1196 Gland, Switzerland by 30 April, 1983.



Imperial College of Science and Technology

"NEW BLOOD AND INFORMATION TECHNOLOGY LECTURESHIPS"

Applications are invited for the following lectureships available from 1 October 1983 in the following departments and fields:

1. CHEMISTRY (INORGANIC CHEMISTRY—BIOLOGICAL ASPECTS OF METAL COMPLEXES OR MAIN GROUP COMPOUNDS)

—Bio-inorganic chemistry, inorganic reaction mechanisms or main group synthetic chemistry.

2. CHEMISTRY (SPECTROSCOPY OF SURFACES)

—the physical chemistry of surfaces investigated by spectroscopic techniques including those provided by the central facilities of SERC.

3. CHEMICAL ENGINEERING AND CHEMICAL TECHNOLOGY (COLLOID SCIENCE APPLIED TO BIOTECHNOLOGY)

—study of manipulation and control of concentrated suspensions of bioactive material and colloidal interactions during the growth and later in the flocculation and filtration procedures used to separate and harvest the micro-organisms

4. CIVIL ENGINEERING (HYDRAULICS)

—expertise in finite element methods and interest in applications to coastal dynamics and open channel flow.

5. CENTRE FOR ROBOTICS (AUTOMATION ROBOTICS)

—research activities cover the following disciplines: mechanical engineering, production engineering, micro-electronics, computing and physics. Applicants should have interests in sensor technology or in the manufacturing technology.

6. METALLURGY AND MATERIALS SCIENCE (EXTRACTION METALLURGY AND MATERIALS PRODUCTION)

—chemical thermodynamics and chemical process engineering as applied to defining and developing new process routes for extraction metallurgy and for the production of a wide range of materials.

7. MATHEMATICS (APPLIED MATHEMATICS AND MATHEMATICAL PHYSICS—FLUID MECHANICS)

—problems in fluid mechanics, transition to turbulence, meteorology, statistical mechanics and laser optics involving the study of differential equations which introduce the concept of strange attractors and associated problems of chaos.

8. MATHEMATICS (PURE MATHEMATICS—PROBABILITY THEORY)

—the connections of probability theory with analysis, number theory, statistics and theoretical physics. Applicants should be strong in functional analysis.

9. PHYSICS (EXPERIMENTAL/THEORETICAL PARTICLE PHYSICS)

—appointment in either High Energy Nuclear Physics Group or Theoretical Physics Group.

10. PHYSICS (PLASMA PHYSICS OF CONDENSED MATTER PHYSICS)

—appointment in one of the following research groups: Optics (lasers), Plasma Spectroscopy, Experimental or Theoretical Solid State, Surface Physics

Information Technology

1. Computing—research in area of 8KBS functional languages or related software engineering areas.

2. Computing—two teaching posts for an undergraduate and/or a graduate conversion course in Computing Science, with strong Software Engineering bias.

Candidates should normally be less than 35 years of age (excluding the appointments in computing) but exceptionally well qualified just over this limit may be considered. Appointment will be at an appropriate point on the Lecturer scale £7531-£14 663 per annum (London Allowance (under review)). Further particulars of these appointments from the Personnel Secretary, Imperial College of Science and Technology, London SW7 2AZ, to whom applications including curriculum vitae, list of publications and names of two referees should be sent to arrive no later than 20 May 1983.

INDEPENDENT SIXTH-FORM COLLEGE IN LONDON AND BIRMINGHAM —\$50 STUDENTS

Required for September; young, enthusiastic graduate tutors for 'A' and 'O' level classes in all subjects, especially Science and Maths. Classes are seven or fewer with no extra curricular activities involved. Competitive remuneration package. Write with C.V. to Box No. D724

INVERTEBRATE ZOOLOGIST

Required as member of team on MSC funded ecological survey of Kennet and Avon Canal, and environs near Reading. Max 12 months, £60 pw, 32 1/2 hr pw. CVS to John E. Matthews, K&A Canal Project Manager, Berkshire County Council, Shire Hall, Shinfield Park, Reading RG2 9XG.

MONASH UNIVERSITY Australia

Department of Chemical Engineering

LECTURER-SENIOR LECTURER-CONTINUING

Three continuing positions at Lecturer or Senior Lecturer level are offered partly as a result of the promotions of D. V. Beger and J. B. Agnew to the Chairs at Melbourne and Adelaide Universities. Preferred areas include Biochemical Engineering, for which a biochemist with strong mathematical background would be considered, and Computer Applications to Process Modelling, Design and Control. However outstanding applicants in any of the main areas of chemical engineering which includes process metallurgy will be considered. Applicants must possess an honours degree or equivalent, demonstrated research ability (eg PhD) and/or relevant industrial experience.

Duties include undergraduate and postgraduate teaching, some administrative duties, supervision of research students and the conduct of research.

Salary: \$A30-\$A29 487 pa
(Lecturer); \$A30 096-\$A35 077 pa (Senior Lecturer).

Superannuation, Outside Studies Programmes, travel and removal expenses, temporary housing assistance.

Enquiries to Professor O. E. Potter. Applications including ref no 26012, curriculum vitae and three referees to the Registrar, Monash University, Clayton, Vic 3168, Australia. A copy to the Australian Association of Commonwealth Universities (Appt), 38 Gordon Square, London WC1H 0FF, by 30 June, 1983.

UNIVERSITY OF LEICESTER

Department of Microbiology
POST-DOCTORAL

RESEARCH FELLOW

Applications are invited for a three year post-doctoral research position supported by the Wellcome Trust. The project is to investigate the expression of poliovirus cDNA in E. coli in order to gain information relevant to the development of new poliovirus vaccines.

Previous experience of recombinant DNA techniques and/or virology would be an advantage but is not essential.

Applicants (PhD) should send a detailed curriculum vitae and the names of two referees to Dr J. W. Almond, University of Leicester, Department of Microbiology, University Road, Leicester LE1 7RH. Tel 0533-561234, as soon as possible.

REDBRIDGE HEATH AUTHORITY

Barking Hospital
Upney Lane, Barking, Essex
MEDICAL LABORATORY
SCIENTIFIC OFFICER

Applications are invited for the above post from State Registered MLT's with experience in routine bacteriology.

Candidates with suitable science degrees or studying for TEC higher certificate will be considered, and the person appointed will be encouraged to study for the IMLs special examination in Bacteriology.

For further details and/or to arrange an informal visit to the department contact Mrs J. Hook on 01-594 3858 ext 282.

Application forms from Personnel Department, King George Hospital, Newbury Park, Ilford, Essex. Tel 01-554 7197. Ref 3041.

Company Micro-Biologist

Hydron Europe, one of Europe's largest manufacturer of CONTACT LENSES has a vacancy for a qualified person to take charge of a small laboratory function in their Farnborough factory.

The principle duties will include:—

- sterility testing of contact lenses and of contact lens solutions;
- environmental monitoring of the factory.

The successful candidate will also be able to regulate work at Consultant Laboratories on a range of associated products and will be competent to prepare license applications for submission to various regulatory bodies.

Candidates should be aged 21-30, suitably qualified in Applied Biology of Medical Laboratory Science and preferably have up to two years industrial experience.

Salary paid will be competitive and progressive, free life assurance, a contributory pension scheme and membership of P.P.P. are provided.

Applications to Lynne Green, Personnel Manager.

HYDRON EUROPE

Hawley Lane, Farnborough, Hampshire.
Tel: Farnborough 516151

UNIVERSITY OF EAST ANGLIA
Norwich

LECTURER IN APPLIED MATHEMATICS (Theoretical Mechanics)

Applications are invited for this lectureship in the School of Mathematics and Physics which is available from 1 October 1983 under the UGC's "New Blood" scheme. The primary role of the lecturer in the early years will be to contribute substantially to research. Salary on the scale £6375-£13505 per annum (under review) plus USS benefits.

Candidates should have a strong research interest in the area of continuum mechanics and/or mechanics of solids.

Applications (three copies, giving names of three persons to whom reference may be made) should be lodged with the Establishment Officer, University of East Anglia, Norwich, NR4 7JZ, from whom further particulars may be obtained, not later than 14 May, 1983. No forms of application are issued.

UNIVERSITY OF LIVERPOOL
Department of Geography
TECHNICIAN GRADE 3

To participate in running an active research and advanced teaching laboratory. Duties include chemical pollen and diatom analysis, palaeomagnetic and "mineral" magnetic measurements, data processing and various types of field work. Candidates must possess OGC or equivalent as minimum qualification plus three years appropriate experience.

Salary within range £4029-£5775 pa. Application forms may be obtained from the Registrar, The University, PO Box 147, Liverpool L69 3BX. Ref. RV/914.

CITY HOSPITAL

BASIC GRADE CYTOGENETICIST

Full-time

Applications are invited for the post of Basic Grade Cytogeneticist in the South Trent Sub-Regional Cytogenetics Service at the City Hospital, Nottingham. This is a new post which has been introduced to allow the development of more detailed cytogenetic analysis of haematological disorders. Candidates should have a first or second class honours degree in Genetics or in a Biological Science with a substantial Genetics component.

Salary and terms and conditions of service are as defined by the Whitley Council Professional and Technical "A" handbook together with some local conditions of employment.

Further information about this post can be obtained by ringing Dr Pat Cooke on Nottingham 608111 ext 2785 or by visiting the department. All short listed candidates are encouraged to visit the department on the day of interview.

Application forms are available from the Personnel Department, Unit HQ, City Hospital, Hucknall Road, Nottingham NG5 1PD. Tel 625459 (answerphone).

Closing date for the return of completed application forms is 6 May 1983.

Nottingham Health Authority

Experimental Physicists

Two Experimental Physicists with honours degrees or doctorates are required for research in nuclear fusion on either:

- the physics of hot plasmas (above 10M°K) in tokamak devices which are the favoured route to fusion reactors, or
- applying high power microwave techniques in the 30 to 100 GHz band for electron cyclotron resonance heating of tokamak plasmas.

The research is in the Experimental Division of Culham Laboratory which is the United Kingdom Atomic Energy Authority's centre for nuclear fusion research.

The appointments will be in the Scientific Officer or Higher Scientific Officer grade according to age and experience with salary in the range of £5,805-£7,920 or £9,205-£11,735.

Write or telephone for an application form to: Mrs P.A. Halliday, Personnel Department,

Culham Laboratory, Abingdon,
OXON OX14 3DB. Telephone:
Abingdon (0235) 21840
Ext. 4391.



Culham
Laboratory

University of Strathclyde

RESEARCH ASSISTANT COMPUTER SCIENCE

Applications are invited for a Research Assistantship in the Department of Computer Science. Appointment will be for 12 months. The research project, conducted under the supervision of Professor A. J. T. Colin, is concerned with the linking of several robots, computers, vision servers and other machines with the STRATHNET or Local Area Network, and the development of a protocol suitable for data transfer in a Flexible Manufacturing System.

Candidates should have a good honours degree or equivalent experience in Computer Science or Electronics.

Appointment will be on research grade IA, with initial placing up to £7225 pa according to age and experience. USS benefit.

Applications (two copies, including curriculum vitae and names and addresses of three referees and quoting reference RDF 3/83) should be lodged by 20 May 1983 with Professor A. J. T. Colin, Livingstone Tower, 26 Richmond Street, Glasgow G1 1XH, from whom further particulars can be obtained.

British Museum (Natural History)

Deputy Librarian -

Palaeontology Library

The British Museum (Natural History) Library is a national library specialising in the biological and earth sciences with a stock of 750,000 volumes and some 8000 current periodicals. It comprises a general library and five departmental libraries: palaeontology (including physical anthropology), botany, entomology, mineralogy and zoology with a specialist ornithological library located at the Zoological Museum, Tring.

The Deputy Librarian will be responsible for the day-to-day running of the palaeontology library, particularly in the management and development of the collection and dealing with enquiries from staff and visitors.

Candidates must have an honours degree or equivalent in biological or earth sciences, preferably geology. Library qualifications and/or experience would be advantageous.

Appointment as Scientific Officer £6640-£8615 (including £1230 inner London Weighting) with starting salary according to qualifications and experience.

For further details and an application form (to be returned by 13 May 1983) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551. (answering service operates outside office hours). Please quote ref: SB/75/DK.



BIRKBECK COLLEGE (University of London) COMPUTER PROGRAMMER

A vacancy exists in the College Central Computing Services Unit for a programmer to provide specialist advice relating to the use of College computers with particular reference to graphics. Candidates are expected to have programming experience in Fortran and the ability to produce clear documentation and to work in close liaison with users. Experience of the use of graphics software desirable. The appointment will be on the scale £7593-£12 263 pa (under review) including London Weighting according to qualifications and experience. Further details and application forms from the Assistant Secretary (Personnel) (NS), Birkbeck College, Malet Street, London WC1E 7HX or tel 01-580 6622, ext 528, or apply with full cv in triplicate and names of two referees.

THE CITY UNIVERSITY DEPARTMENT OF INFORMATION SCIENCE

RESEARCH ASSISTANT

Salary on scale £6375 to £7655 p.a. plus £158 p.a. London Allowance.

The appointment will be for the period 1 June, 1983 to 31 March, 1985, and will involve data collection by interview and questionnaire, quasi-linguistic analysis of textual data, and substantial computing for information retrieval. Applicants should be prepared to work in this entire range of topics.

Candidates should preferably have a post-graduate qualification in information science, cognitive studies, artificial intelligence or non-numerical computing, or a related field, although those with good honours degrees will be considered.

Forward curriculum vitae (including summaries of research, and names and addresses of two referees), to Dr N. J. Belton, Department of Information Science, The City University, Northampton Square, London EC1V 0AH, by 2 May, 1983. Further details may be obtained from Dr Belton by writing to the above address, or by telephoning 01-253 4399 ext 3902 or 3901.

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EXPERIENCED GRADUATE ANALYTICAL CHEMIST

We wish to recruit an experienced Analytical Chemist to work on the analysis of a wide range of pharmaceutical and toiletry products. Applicants must have a good working knowledge of modern instrumental techniques and preference will be given to those applicants with prior experience in the pharmaceutical industry.

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Please write, enclosing CV to Mrs Jeni Money at the above address, or alternatively telephone her on Egham 34422 for further information.

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For further details, contact Alistair Ross or Penny Warren on 01-222 1547 (24 hours).



Ross Warren Recruitment

We are a leading company in the supply of analytical equipment world-wide and are searching for an

APPLICATIONS ASSISTANT

to work in the field of energy-dispersive X-ray spectrometry. The job will involve the preparation and analysis of submitted samples and the subsequent production of application re-reports. The successful candidate will have a sound scientific background (Chemistry, Physics, Earth Sciences) and will preferably have some practical analytical experience.

Applications with CV and referees to:

Dr A. T. Ellis, Link Systems Ltd, Halifax Road, High Wycombe, Bucks HP12 3SE. Tel: (0494) 442255.



UNIVERSITY OF KENT AT CANTERBURY

Chemical Laboratory POSTGRADUATE RESEARCH ASSISTANT

Applications are invited for a three-year appointment funded by the SERC, to study inorganic and organometallic compounds by micro-calorimetry and to assist in the construction and development of calorimetric equipment. Applicants should preferably hold or expect to achieve an Honours degree in chemistry or a chemistry-related science. The successful candidate may be able to register for a higher degree. Starting salary £5590 pa. Further particulars can be obtained from Professor J. A. Connor, Chemical Laboratory, University of Kent, Canterbury, Kent CT2 7NH, to whom applications, including a curriculum vitae and the names and addresses of two referees, should be sent, not later than 30 June 1983. Please quote reference A10/83/NS.

UNIVERSITY OF LEICESTER LECTURESHIP IN GENETICS

Applications are invited for the position of Lecturer in Genetics. This post has been awarded by the University Grants Committee under the "New Blood" scheme.

Applicants must have at least two years' postdoctoral experience in Molecular Genetics and should preferably have an interest in the structure of the Human Genome with particular reference to the molecular basis of Inherited Disorders. Outstanding young scientists with related interests such as in mammalian gene expression or in developmental genetics may be considered.

Initial salary will depend upon qualifications and experience on the Lecturer's scale £6875 to £18,660. Further particulars from the Registrar, University of Leicester, University Road, Leicester LE1 7RH, to whom applications should be sent on the form provided by 6 June, 1983.

oxford polytechnic

LECTURER II/SENIOR LECTURER IN GEOCHEMISTRY

Applications are invited for the post of Lecturer II/Senior Lecturer in Geochemistry tenable in the Department of Geology & Physical Sciences from 1 September 1983. The successful applicant will be expected to take charge of and to develop the Department's wet geochemical facilities and to teach all aspects of geochemistry within the Department's undergraduate courses in Geology and Earth Sciences. An interest in teaching introductory geology to first year students will be an advantage. The person appointed will be expected to contribute fully to the Department's fieldwork programme and will be expected to undertake an active programme of research including the supervision of geochemistry undertaken by research students.

Salary according to qualifications and experience in the following ranges:

Lecturer II £6855-£11 022
Senior Lecturer £10 173-£12 816

An application form and further details of the appointment and the Department may be obtained from the Head of Department, Department of Geology & Physical Sciences, Oxford Polytechnic, Headington, Oxford OX3 0BP.

Closing date: 9 May 1983.

UNIVERSITY OF BRISTOL

Long Ashton
Research Station
STATISTICIAN

required in the Biometrics Section to collaborate with experimenters in planning investigations on the protection and developmental physiology of arable crops, and in the analysis and interpretation of the results.

Minimum qualifications: Degree in Statistics, or a biological subject with Statistics, or HNC with relevant experience.

Starting salary according to qualifications and experience. Scientific Officer (£5422-£7399 pa) or Higher Scientific Officer (£6840-£9126 pa). At least five years' relevant post-graduate experience is required for appointment to the higher grade. Non-contributory superannuation scheme.

Further particulars and application forms from the Secretary, Long Ashton Research Station, Long Ashton, Bristol BS18 5AP, to whom applications should be sent by 17 May 1983.

UNIVERSITY OF NOTTINGHAM

Department of Mathematics
Applications are invited for a
LECTURERSHIP

established under the national scheme to encourage the appointment of younger members of the academic staff (the "New Blood" scheme) and tenable in this Department. Probability/Statistics with Biological/Medical applications. Applicants should have theoretical and biological/medical applied interests in Stochastic Processes and/or Time Series. In particular, we wish to encourage applicants whose research includes any of: Counting Processes and Survival Data; Stochastic Differential Equations and Biological Phenomena; Development of Non-linear/Non-stationary Time Series of Time Series Models.

Applicants should normally be under the age of 35 years and salary will be within the range £6375-£13 505.

Further particulars and application forms, returnable not later than 9 May, 1983, should be obtained from the Staff Appointments Officer, University of Nottingham, University Park, Nottingham NG7 2RD. Ref no 861.

University of Edinburgh
Department of Agriculture

Applicants are invited for the post of

LECTURER

in Applied Animal Ethology in the Edinburgh School of Agriculture.

Applicants should have a formal grounding in both ethology and animal production, as well as research experience in Applied Ethology with farm animals.

Further details from and applications (six copies, giving the names of two referees) to the Secretary to the University, Old College, South Bridge, Edinburgh EH8 9YL, not later than 8 May, 1983.

Please quote Reference No. N89

ST GEORGE'S HOSPITAL MEDICAL SCHOOL (University of London)

TECHNICIAN 3 or 5

Required in Immunology Department from June for three years to join an established research group raising B cell hybridomas and T cell clones against parasite components.

Applicants should have a background in Immunology, Biochemistry or Microbiology and candidates for grade 5 position should have at least 8 years experience. Initial emoluments up to £6508 p.a.

Further particulars and application form available from the Establishment Officer, St George's Hospital Medical School, Cranmer Terrace, London SW17 0RE. Quote ref TIM.

STUDENTSIPS

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Physiological Flow Studies Unit

PHD STUDENTSHIP

A student, with sound engineering or physical science background, is required to work on a PhD project involving the application of chemical engineering science to a topic of considerable importance in pulmonary physiology.

The project is concerned with the uptake of soluble gases by the airways of the lung during breathing. It involves a study of the flow and mixing processes and wall mass transfer in systems of short branching tubes. Both experimental and computer modelling studies will be undertaken.

The successful applicant may expect to receive a studentship award in excess of £3500 dependent on qualifications. Further details may be obtained from Dr R. C. Schroter, Physiological Flow Studies Unit, Imperial College, London, SW7 2AZ. Tel 01-588 5111, ext 1802.

SEALE HAYNE COLLEGE
NEWTON ABBOT
DEVON

Applications are invited for a

MAFF POST GRADUATE STUDENTSHIP

on

"Water utilisation by pigs under various conditions of housing, feeding and management"

Candidates should possess or expect to obtain in 1983 a First Class or Upper Second Class Honours degree in an appropriate subject. The successful candidate will be expected to register for a higher degree.

Applications should be made to: The Vice Principal.

Seale-Hayne College, Newton Abbot, Devon TQ12 6ND.

Further particulars can be obtained from the Vice Principal.

The University of Birmingham
Department of Chemical Engineering

SERC/CASE

Research Studentship

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PARTICLE SIZE REDUCTION

energy use and processing implications

The aim is to correlate fundamental studies of the energy used in particle breakdown to a test cell at Birmingham, with industrial processes being considered by SERC's mineral processing unit at Sunbury, with the goals of improved efficiency and design methods.

Applications should be made to: Dr J. W. Armitage, Department of Chemical Engineering, University of Birmingham, PO Box 363, Edgbaston, BIRMINGHAM B15 2TT. Telephone: 021-472 1301 Ext 3638.

UNIVERSITY OF NEWCASTLE UPON TYNE

NERC RESEARCH
STUDENTSIPS IN
GEOPHYSICS AND
PLANETARY PHYSICS

Research studentships are available in the Department of Geophysics and Planetary Physics for work starting in October 1983 and leading to a PhD degree on the following projects:

Cryotectonic magnetization fabrics (Dr D. H. Tarling and Prof M. B. Hart); Thermomagnetic magnetization in iron sulphides (Dr W. O'Reilly); Laboratory homogeneous dynamos and their relationship to planetary magnetic field generating mechanisms (Dr I. Wilkinson).

Other projects may be available in the department for students with a non-environmental science degree (chemistry, physics, mathematics, engineering etc) by mutual agreement.

Applicants must hold, or expect to obtain, a first or upper second class degree and normally must have been resident in the UK, or of Man or Channel Islands for the last three years.

Further details available from Mr J. M. Walmsey, Administrative Officer, School of Physics, The University, Newcastle upon Tyne NE1 7RU.

UNIVERSITY COLLEGE LONDON

Biotechnological Engineering and
Biotechnology

SERC STUDENTSIPS

for biochemical engineers, biochemists, microbiologists, chemical engineers.

1. Collaborative (CASE) project with Unilever Research on the interesterification of fats using immobilised enzymes.

2. Collaborative (CASE) project with G. D. Searle on the production of L-tryptophan by immobilised cells.

3. Collaborative (CASE) project with the Protein Fractionation Centre, Edinburgh on acoustic conditioning of human plasma protein precipitates.

4. Research studentship on biochemical engineering aspects of the fractional precipitation of enzymes, linked with the SERC supported special programme on protein technology.

Application forms from the Departmental Secretary, Department of Chemical and Biochemical Engineering, University College London, Torrington Place, London WC1E 7JE.

UNIVERSITY OF NOTTINGHAM

STUDENTSHIP
MICROBIOLOGY—
PHARMACEUTICAL
CHEMISTRY

Applications are invited for a studentship, expected to lead to the degree of PhD for research into novel compounds which by modifying host defences augment the responses of infection to antibiotics. The student will be concerned with the cellular events underlying these responses and should possess or shortly expect to obtain a first or upper second class honours degree in biochemistry, microbiology, immunology or other appropriate subject.

Further details and application forms from Professor J. O'Grady, Department of Microbiology, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH. Closing date for applications 16 May, 1983.

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oxford polytechnic

NERC RESEARCH STUDENTSHIPS

Geological Studies of Marginal Basin Rocks in SW Viti Levu, Fiji

Applications are invited for the above studentship tenable from 1 October 1983, which will be under the joint supervision of Drs H. Colley and R. J. Sutherland in the Department of Geology & Physical Sciences. The topic will involve fieldwork in Fiji and will be primarily concerned with the chemistry, facies types and dating of marginal basin volcanic and sedimentary rocks.

Candidates will have, or will expect to obtain in 1983 a first or upper second class honours degree in the geological sciences.

Further details from, or letters of application, including curriculum vitae and names of two referees to the Head of Department, Department of Geology & Physical Sciences, Oxford Polytechnic, Headington, Oxford OX3 0BP.

Closing date: 6 May 1983.

Candidates with research interests in other areas, who may wish to be proposed for NERC Appeal Awards are also invited to write to the Head of Department at the address given above.

UNIVERSITY OF NOTTINGHAM

Department of Microbiology

MRC RESEARCH STUDENTSHIP

Applications are invited from candidates who possess or shortly expect to obtain first or upper second class honours degrees in appropriate subjects for a research studentship expected to lead to the degree of PhD. The student will be concerned with either the importance of *Acinetobacter* as a reservoir of antibiotic resistance genes and their transfer to more pathogenic species or the response of bacteria to antibiotics in mechanical models simulating the conditions of infected lesions.

Further details and application form from Professor F. O'Grady, Department of Microbiology, University Hospital, Queen's Medical Centre, Nottingham NG7 2UH.

Closing date for applications 16 May 1983.

ROYAL FREE HOSPITAL SCHOOL OF MEDICINE

(University of London)

MRC RESEARCH STUDENTSHIP

IN MEDICAL STATISTICS

Applications are sought from suitably qualified persons (eg MSc in statistics) to carry out research leading to a PhD in medical statistics. The research involves working with a multidisciplinary team on the analysis of data from a large survey into the causation of heart disease. In addition, the research student will receive a broad education relating statistics to many different areas of medical research.

Further details may be obtained from Dr S. J. Pocock, Department of Clinical Epidemiology and General Practice, Royal Free Hospital School of Medicine, Rowland Hill Street, London NW3 2PP, to whom applications, giving names of two referees, should be sent as soon as possible.

UNIVERSITY OF BATH

School of Engineering

RESEARCH STUDENTSHIP

A research student is required in connection with a government funded project concerned with exploring the use of ceramic materials in Diesel engine combustion chambers as a means of raising thermal efficiency.

The work which is part of a large Diesel engine research programme, will involve both experimental work on rigs and engines, and analytical work based on finite element analysis for heat flow and stress, and cycle simulation models.

The studentship will be tenable for three years, remuneration being at standard SERC rates.

A good Honours Degree in Mechanical Engineering, coupled with an interest in new materials are essential qualifications.

Enquiries should be addressed to Professor F. J. Wallace, School of Engineering, University of Bath, Bath BA2 7AY.

THE ANIMAL VIRUS RESEARCH INSTITUTE

POSTGRADUATE STUDENTSHIP

Applications are invited for a postgraduate studentship at the Animal Virus Research Institute to work on the immunology of African swine fever or of foot-and-mouth disease.

The Studentship (supported by the Agricultural Research Council) will be tenable for three years from October and the successful candidate will be expected to read for a higher degree. Applicants should have, or expect to obtain, a good honours degree in immunology and/or microbiology.

Application forms and further particulars may be obtained from the Secretary, Animal Virus Research Institute, Pirbright, Woking, Surrey GU24 0NP. (Tel 0483) Worplesdon 323441).

ARC RESEARCH STUDENTSHIP AT THE SCOTTISH INSTITUTE OF AGRICULTURAL ENGINEERING AND UNIVERSITY OF STRATHCLYDE

Applications are invited for an Agricultural Research Council Research Studentship, tenable at the Scottish Institute of Agricultural Engineering and the Energy Studies Unit of University of Strathclyde from October 1983. The successful applicant will be able to enroll for the degree of MSc or PhD.

The research topic will be a study of energy supply and demand in Scottish agriculture. This will involve the collection and analysis of data, and categorisation by farm type. Some attention will also be given to the economic implications of fuel prices and the potential of renewable energy sources.

Candidates should hold, or expect to obtain in 1983, a first or upper second class honours degree in a branch of Engineering or Science. A degree in Agriculture, if backed with adequate skills, could also be acceptable.

Application forms and further details from the Secretary, Scottish Institute of Agricultural Engineering, Bush Estate, Penicuik, Midlothian EH26 0PH: Tel 031 445 2147.

Closing date 12 May, 1983.

KINGS COLLEGE HOSPITAL MEDICAL SCHOOL

(University of London)

Denmark Hill

London SE5 8RX

MRC RESEARCH STUDENTSHIPS IN BIOMEDICAL ENGINEERING

Applications are invited for MRC Research Studentships. The successful applicants will join a large, multi-disciplinary team working on the application of engineering and technology to medicine. The studentships will be concerned with one of two major areas: (i) the use of pulsed wave Doppler ultrasound in the diagnosis and screening of patients at risk from stroke, and (ii) the modelling of the vascular system and its role in the diagnosis and treatment of peripheral vascular disease.

Applicants should possess a first class or upper second class science degree in either Mechanical Engineering, Electrical or Electronic Engineering, Applied Physics or Applied Mathematics.

Applications, giving a full curriculum vitae and the names and addresses of two referees, should be sent to Dr V. C. Roberts, Deputy Director, Department of Biomedical Engineering at the above address, from whom further information may be obtained. Closing date 19 May, 1983.

UNIVERSITY OF EDINBURGH RESEARCH STUDENTSHIPS

Applications are invited from graduates in Mathematics or the Physical Sciences for two Studentships tenable from October 1983.

Observational and modelling studies related to the theory of climate

Factors affecting the acidity of rainfall
For further details apply to Department of Meteorology, Kings Buildings, University of Edinburgh.

SERC CASE STUDENTSHIP

HETEROGENEOUS CATALYSIS

A SERC Case Studentship is available to investigate selected heterogeneous catalytic reactions using novel solid state electrochemical techniques in collaboration with ICI agricultural division. For further details contact Professor B. C. H. Steele, Department of Metallurgy and Materials Science, Imperial College, London SW7 2BP.

LECTURES, MEETINGS AND COURSES

UMIST

MSc COURSE IN INTEGRATED CIRCUIT SYSTEM DESIGN

One year full-time MSc course in the Design and Fabrication of Microelectronic Components, Semi-Conductor Devices and Systems. Student-designed circuits will be manufactured by local industry.

Applicants invited from Honours Graduates in Electronic Engineering, Computer Science and Physics, or from holders of equivalent professional qualifications. Course recognized by SERC for Advanced Course Studentships. Details and application forms from: Postgraduate Admissions Officer, Department of Electrical Engineering and Electronics, UMIST, PO Box 88, Manchester M60 1QD. Please quote reference EEE/C5/AJ.

UNIVERSITY OF TECHNOLOGY LOUGHBOROUGH

ONE DAY SHORT COURSE ON STRAIN MEASUREMENT

Wednesday 18 May 1983

This course covers a wide variety of methods, including resistance strain gauges, photoelasticity, laser moiré and holography. The fee is £50, covering course notes, lunch and other refreshments.

Please contact Dr D. J. Perry, Department of Physics, University of Technology, Loughborough, Leics LE11 3TU. Tel (0509) 263171.

The 20th Culham Plasma Physics Summer School

to be held at Culham Laboratory, Abingdon, Oxfordshire, U.K. 4th - 15th July 1983

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Plasma Physics
Astrophysical Plasmas

VISITS AND DISCUSSIONS

Culham Laboratory
Fusion Experiments
JET Laboratory

Laser-Plasma Experiments
Panel Discussion on
Theory and Experiments

APPLICATIONS

Applications are invited from post-graduate and other research workers. Application forms and further details are available from:

MARJORIE SADLER, THE SUMMER SCHOOL OFFICE, CULHAM LABORATORY, ABINGDON, OXFORDSHIRE, OX14 3DB, U.K.

CLOSING DATE FOR APPLICATIONS: 13 MAY 1983

Like applications may be accepted.



KINGSTON POLYTECHNIC

GRADUATESHIP OF THE ROYAL SOCIETY OF CHEMISTRY Part II ONE YEAR FULL-TIME COURSE

Applicants should hold a BSc degree with chemistry as a main subject or equivalent. 1. Students may be eligible for an U.K. grant.

Next intake September 1983

Further details and application forms from:
Dr R. Long, Head of School of Chemical and Physical Sciences, Kingston Polytechnic, Pyram Road, Kingston upon Thames, Surrey, Middlesex, U.K. 01-545 1388 ext 308

The Impact of Health and Safety Legislation on the Industrial Users of Chemicals

A three-day residential course to be held at the University of York from 20-22 September 1983. Speakers will be drawn from HSE, industrial companies, the legal profession and Universities. For further details contact:

Dr R. C. Gomer, Cancer Research Unit, University of York, Heslington, York YO1 5DD.



LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

One-day Short Course

METHODS OF SURFACE ANALYSIS

Wednesday 25 May 1983

A number of techniques are now available to measure the composition of the outermost surface layers of solid materials. This one-day course is aimed at introducing the non-specialist in industry to the analytical information available from Auger electron spectroscopy, ESCA, SIMS and Rutherford backscattering and the ways these techniques can be used to solve problems on surfaces, thin films and surface coatings. Further details from Dr J. M. Walls, Department of Physics, Telephone (0509) 263171, ext. 5249.

CITY OF LONDON POLYTECHNIC
MSc NEUROPHYSIOLOGICAL BASIS OF BEHAVIOUR
Applications are invited for this two-year, part-time evening course leading to an MSc under CNAA Regulations, commencing September 1983. Further details may be obtained from Dr D. B. Lewis, Department of Biological Sciences, City of London Polytechnic, Old Charles Street, London E1 7NT.

MSC MOLECULAR SCIENCE OF MATERIALS

by full-time or part-time study

POSTGRADUATE DIPLOMA ELECTRONIC AND MOLECULAR PROPERTIES OF MATERIALS

by part-time study

Opto-electronic materials and display technology, glasses and polymers with applications to the electronic and polymer industries.

Details and application forms from the Head of School, Materials Science and Physics, Thames Polytechnic, Wellington Street, London SE18 4PF. Telephone: 01-854 2030, extension 382.

FELLOWSHIPS, GRANTS, SCHOLARSHIPS

CHELSEA COLLEGE

University of London
TEMPORARY TEACHING FELLOWSHIP IN CHEMISTRY
A vacancy is available for a Teaching Fellow in Chemistry, partially supported by a grant from the Ministry of Agriculture, Fisheries and Food. The successful applicant, who should have first-hand experience of FT nmr technique, will be expected to divide his/her time between normal teaching duties and a research programme designed to evaluate the application of medium and high-field nmr spectroscopy to the chemistry of mycotoxins and other low-concentration food contaminants.

Initial appointment will probably be within the first five points of the Lecturer's scale (plus London Allowance) and should be taken up by 1 October at the latest. The appointment will be offered for one year in the first instance. Application forms and further details may be obtained from the Personnel Office, Chelsea College, 504 King's Road, London SW10 0UA. The closing date for receipt of applications is 12 May, 1983.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY
TWO SERC CASE GRANTS
are available for postgraduate research on corrosion (1) in Flue Gas Condensates and (2) in Coal Gasifier Atmospheres. Applications, including curriculum vitae and names of two referees, to: Dr M. O. Stocker, Department of Metallurgy and Materials Science, Imperial College, London SW7 2BP. Tel 01-588-5111, ext. 1708.

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ARIADNE

ACID rain has been a topic in the pages of this magazine for years and a frequent one recently. I am told by an employee of ICI that there was a curious example of the effects of it some time back. It could be seen any day in the car parks attached to various chemical plants in the Runcorn area. The higher grades of employee were supplied, as was the custom with many firms, with shiny, new company cars. But the car parks had few. Most of the space was taken up by old Morris Minors and the cheaper end of the Ford range, possibly second-hand.

The reason was that the atmosphere was corrosive, mainly because of waste acid from the sulphuric acid plant, vented to the outside air. Cellulose is not proof against attack and it was reckoned that a new car's shine would be ruined in about two years. So people went to work in shabbier vehicles.

There is no present problem. For one thing, ICI now scrubs the wastes clean and makes money on the products and has also made good use of heat previously going up the chimney stacks. For another, it does not hand out new cars as it used to. □

THE season is coming up, unfortunately, when one of the worst forms of pollution is about to make its reappearance on the streets. That is, deafening row from loudspeakers in cars with their windows open. Sitting in a traffic jam with such a car alongside is a contemporary purgatory that produces reactions in me that bode no good for the future of the human race and make me a menace on the roads for minutes afterwards. The car is generally occupied by an idiot or two gazing strictly ahead either with expressions that lead you to think that they are convinced they are doing everyone else a favour, or that they are only sitting down because they have insufficient brain to walk and chew gum at the same time.

On the other hand, I hope I am right in detecting a reduction in one source of noise and that is from the otherwise frightening motor cyclists who work for messenger firms. They used to have loudspeakers on the back of their machines that bawled out backchat and delivery instructions to everyone within a radius of a hundred yards. I have not heard so much of this recently. Perhaps radio is now fitted inside the crash helmets. I never understood why this could not have been done in the first place, along the lines of the

radios issued to policemen or the earphones that, thank God, are popular with those who cannot live without constant noise. □

IF YOU watch television and listen to news-readers, leaders of industry, pop-bawlers and "presenters", you could make a whole glossary of words that have been shortened in the interests of inarticulacy and idleness.

For instance, the fifth of Febry might see the Pry Minister on an itinery talking to prone antimarketeers, including trade unists and finey, Percy opening a storny new libry building. Certainly, she would make an authoritative statement on behalf of the gummunt, though it would not be in monosybls, for which we should all be grayful. Things might deteriorate because of terrorist activities in island, of course, but only tempry and her seckerterries of state could then get on with seprut plans for denatensisation. □

WE ARE all members one of another, as the saying goes. Also, as Louis Armstrong sang, it's a wonderful world. If you have a go at reading *Hansard*, both truths will force themselves on you, piercing the tedium, loquaciousness and tomfoolery of MPs, especially at question time. Not that I want to suggest that any of those adjectives applies to a question from Jack Ashley to the Health Minister, Kenneth Clarke. It was about injuries and seat belts.

The point of the question was linked to kidney transplants. Kidneys are usually obtained from dead people and many of them from victims of road accidents. Therefore, if the wearing of seat belts reduces accidents, it is also likely to reduce the number of kidneys available for transplant. So far the figures show a variation that is not statistically significant.

It is an odd sidelight, to coin a phrase, on road accidents. I have always had a slightly

suspicious attitude to information on road accidents since the Road Research Laboratory (I think it was), proved some years ago that if you were killed in an accident at any age over forty, you were doing the country an economic favour. □

LAST week, Daedalus described his "Discofilm", which codes the depth-dimension of its image as a false colour. He now has a way of displaying it as a real space-filling 3-D image. The space is a hollow glass tank containing a hot metallic vapour (for example mercury vapour). This is usually quite transparent, but at certain pressures it undergoes a sharp "Mott transition" to an opaque, pseudometallic state that reflects.

So, says Daedalus, launch a shock-wave into the vapour, and the high-pressure wave-front will become momentarily visible as a "metallic mirror", sweeping through the vapour at the speed of sound. It will be matt silver-white and an ideal projection screen.

Launch such shock-screens through the vapour many times a second, and you have an ideal swept-volume for displaying 3-D pictures.

For projection purposes, Discofilm will be given, not visible false colours, but ultraviolet ones. It will also be coated with a bright UV-to-visible phosphor of the kind used in strip-lighting. The film will be projected into the screen volume by a frequency-swept UV source. With careful enough synchronisation, as the source reaches the UV false-colour corresponding to a certain depth into the image, so the moving vapour screen will have reached that depth in its swept volume. The picture elements for the depth, transformed to white light by the phosphor, will thus be instantaneously projected onto the screen at their true relative depth. At (say) 24 scans a second, this front-to-back "painting in" of the image will be too fast to resolve; the

eye will apparently see a real, solid image. With cinematographic Discofilm, it will see a real 3-D movie.

The problems of filling cinema halls with hot mercury vapour are rather daunting, so Discofilm is probably limited to TV-size. A stupendous cinema epic, reduced to a sort of frantic scurrying in a goldfish bowl, might merely seem ridiculous. The swept-vapour screen may be best employed for 3-D computer displays and component visualisation. □



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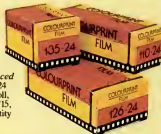
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